The 36$^{\text{th}}$ SIAM Southeastern-Atlantic Section

Annual Conference

March 24-25, 2012

Welcome Message from the Conference Chair

As chair of the 36th SIAM Southeastern Atlantic Section Conference (SIAM SEAS 2012), it gives me great pleasure to welcome you to this meeting and to the University of Alabama in Huntsville.

Over the last 35 years, SIAM SEAS has grown to be a major SIAM conference in the southeast of the United States. SIAM SEAS 2012 continues the tradition of high-quality, broad national participation in all areas of applied mathematics and computational science. The meeting is organized into a set of minisymposia and contributed sessions in wide range of topics in over 185 presentations split between 42 parallel sessions and a poster session.

We are also honored to have Professors H.T. Banks, Susanne Brenner, Jerrold Griggs and Max Gunzburger as plenary speakers. As in our previous conferences, you are presented with many opportunities to network with a diversified colleagues from a variety of different institutions.

The successful organization of SIAM SEAS 2012 has required the talents, dedication and valuable time of many volunteers and strong support from the sponsors. SIAM SEAS 2012 is sponored by the College of Science, the Office of Research at UAH and Society for Industrial and Applied Mathematics.

We hope that you will find the sessions both enjoyable and valuable, and enjoy the interactions among the participants during coffee breaks or the lunches/dinner.

Thank you for attending this conference, and supporting SIAM-SEAS.

With best wishes for an enjoyable and productive conference.

S.S. Ravindran
Chair, SIAM-SEAS 2012.

Registration: 7:00-8:00 AM, Saturday, March 24
Shelby Center Lobby - 1st Floor

8:00-8:10 AM, Saturday, March 24
Opening Remarks: John D. Fix
Dean, College of Science
Shelby Center 107 - 1st Floor

8:10-8:55 AM, Saturday, March 24
IP1 Plenary Talk: Efficient numerical approaches for the simulation and control of PDEs with random inputs
Max Gunzburger, Florida State University, USA (Abstract on page 18).
Shelby Center 107
Chair: S.S. Ravindran, University of Alabama in Huntsville, USA

9:00-11:00 AM
Saturday, March 24
Concurrent Sessions

MS1: Recent Advances in Analysis of Partial Differential Equations - Part I of III(Abstracts on page 18)
9:00 AM - 11:30 AM, Saturday, March 24
Room: Shelby Center 121 - 1st Floor
For Part II, see MS18
Organizers: Emmanuele DiBenedetto, Vanderbilt University, USA; Ugo Gianazza, University of Pavia, Italy

9:00-9:30 AM *On the Inverse Stefan Problem*
Ugur Abdulla and Ogugua Onyejekwe, Florida Institute of Technology, USA

9:30-10:00 AM *Existence Results for the Nonhomogeneous Infinity Laplacian*
Tilak Bhattachariya, University of Western Kentucky, USA

10:00-10:30 AM *Strong Solutions to an Obstacle Problem with Coefficients in VMO*
Ivan Blank and Kubrom Teka, Kansas State University, USA

10:30-11:00 AM *Logarithmically Singular Parabolic Equations as Limits of the Porous Medium Equation*
Ugo Gianazza, University of Pavia, Italy; Emmanuele DiBenedetto, Naian Liao, Vanderbilt University, USA

11:00-11:30 AM *Holder Continuity of a Bounded Weak Solution of Generalized Parabolic p-Laplacian Equations*
Sukjung Hwang, Iowa State University, USA

MS2 Recent Advances in Computational and Stochastic Methods in Fluid Dynamics with Control and Estimations - Part I of II
(Abstracts on page 19)
9:00-11:00 AM, March 24
Room: Shelby Center 158 - First Floor
For part II, see MS10
Organizers: Meng Xu, Rockefeller University, USA
Pani Fernando, Center for Decision, Risk, Controls and Signal Intelligence, Naval Postgraduate School, USA
Sakthivel Kumarasamy, Center for Decision, Risk, Controls and Signal Intelligence, Naval Postgraduate School, USA

9:00-9:30 AM *Robust Airfoil Optimization Using Maximum Expected Value and Expected Maximum Value Approaches*
Ana-Maria Croicu, Kennesaw State University; M. Yousuff Hussaini, Florida State University; Antony Jameson, Stanford University; Goetz Klopfer, NASA Ames Research Center, USA

9:30-10:00 AM *Stochastic Navier-Stokes Equations with Levy Noise*
Pani Fernando and S.S. Sritharan, Naval Postgraduate School, USA

10:00-10:30 AM *An Optimal Control Problem for A Flow of Hamiltonian and Gradient Type in The Space of Probability Measures*

Jin Feng, University of Kansas; Atanas Stefanov, University of Kansas and *Andrzej Swiech*, Georgia Institute of Technology, USA

10:30-11:00 AM *Control of Stochastic Heat-Diffusion Systems under Markovian Switching*
Michael J. Knap and Sivapragasam Sathananthan, Tennessee State University, USA

MS3 Applied and Computational Harmonic Analysis - Part I of III (Abstracts on page 20)
9:00-11:00 AM, March 24
Room: Shelby Center 216 - 2nd Floor
For part II, see MS16
Organizer: Alexander Powell, Vanderbilt University, USA

9:00-9:30 AM *Frame potentials and the dynamical optimization of frames*
Bernhard Bodmann, University of Houston, USA

9:30-10:00 AM *Full Spark Frames*
Jameson Cahill, University of Missouri, USA

10:00-10:30 AM *High order Fourier analysis of infinite-time quantized frame expansions*
N.T. Thao, City College of New York

10:30-11:00 AM *The road to deterministic matrices with the restricted isometry property*
Dustin Mixon , Princeton University, USA

MS4 Advances in Free Boundary Problems - Part I of II (Abstracts on page 21) 9:00-11:00 AM, March 24
Room: Shelby Center 105 - 1st Floor
For part II, see MS27

Organizer: Shawn Walker, Louisiana State University

Abstract: This mini-symposium will explore recent advancement in the mathematical modeling and numerical analysis/scientific computation of a variety of problems that exhibit moving interfaces. Discussion will range from modeling issues to numerical analysis of the computational methods. Application areas include multi-physics applications, phase-field methods, optimal control, fluid-structure interaction, non-Newtonian flows, dynamic meshing, as well as methods for computing with moving interfaces.

9:00-9:30 AM *Optimal Control of a Free Boundary Problem with Second Order Sufficient Optimality Conditions*
Harbir Antil, University of Maryland, College Park, USA

9:30-10:00 AM *A Diffuse Interface Model For Electrowetting With Moving Contact Lines*
Abner Salgado, University of Maryland, College Park, USA

10:00-10:30 AM *Multiscale modeling in DNS of multiphase flows*
Gretar Tryggvason, University of Notre Dame, USA

10:30-11:00 AM *Tetrahedralization of Isosurfaces with Guaranteed-Quality by Edge Rearrangement (TIGER)*
Shawn Walker, Louisiana State University, USA

MS5: Recent Advances in Numerical PDEs and Computational Biology - Part I of III (Abstracts on page 22)
9:00-11:00 AM, March 24
Room: SC218 - 2nd Floor
For part II, see MS19

Organizer: Lili Ju and Xinfeng Liu, University of South Carolina, USA

9:00-9:30 AM *Modeling and simulating tumor growth with therapy*
Jin Wang, Old Dominion University, USA

9:30-10:00 AM *Krylov implicit integration factor methods and applications in pattern solutions*
Yongtao Zhang, University of Notre Dame, USA

10:00-10:30 AM *Mathematical modeling for cell-oscillations*
Xiaoqiang Wang, Florida State University, USA

10:30-11:00 AM *A Multiscale Method for Epitaxial Growth*
Yi Sun, University of South Carolina, USA

MS6 Modeling, Simulation, and Analysis of Phase-field Method in Various Science Fields of Current Interests - Part I of III
(Abstracts on page 23)
9:00-11:00 AM, March 24
Room: Shelby Center 203 - Second Floor
For part II, see MS21

Organizer: Xiaofeng Yang, University of South Carolina, USA
Abstract:
Phase field method has been widely used in many science and engineering fields, for instance, the material science, biomedical science, biology, chemical engineering. As one of the major tools of interface tracking methods, phase field method has some advantages including the physical law and the easiness tracking of the interface. We will probe the current advances of the modeling simulations and analysis of phase-field method in various fields in this minisymposium and hopefully, we can strengthen the communications of interdisciplinary fields and groups

9:00-9:30 AM *The dynamics of two phase complex fluids: drop formation/pinch-off*
Xiaofeng Yang, University of South Carolina, USA

9:30-10:00 AM *Efficient spectral-Galerkin methods for systems of coupled elliptic equations with applications in phase-field modeling*
Feng Chen, Purdue University, USA

10:00-10:30 AM *3-D Numerical Simulations of Biofilm Growth and Interaction with Flows*
Chen Chen, University of South Carolina, USA

10:30-11:00 AM *Modeling of Biocide Action against Biofilm*
Tianyu Zhang, Montana State University, USA

MS7: Asymptotic Dynamics of Dissipative Evolution Equations - Part I of III (Abstracts on page 24)
9:00-11:00 AM, March 24
Room: Shelby Center 205 - Second Floor

For part II, See MS23

Organizers: Wenzhang Huang, University of Alabama in Huntsville and Wenxian Shen, Auburn University

Abstract:
Dissipative evolution equations are used to model many systems in applied sciences. The minisymposium will focus on the asymptotic dynamics, in particular, traveling wave solutions and spreading speeds, of various dissipative evolution equations involving spatial or temporal variations and/or time delays.

9:00-9:30 AM *Poisson-Nernst-Planck type models for ionic flows and ion size effect on I-V relations*
Weishi Liu, University of Kansas, USA; Shuguan Ji, Jilin University, China; Xuemin Tu, University of Kansas; Mingji Zhang, University of Kansas, USA

9:30-10:00 AM *A Reaction-Diffusion Problem with Nonlocal Reaction*
Georg Hetzer, Auburn University, USA

10:00-10:30 AM *Traveling Wave Solutions in Partially Degenerate Cooperative Reaction-Diffusion Systems*
Bingtuan Li, University Louisville, USA

10:30-11:00 AM *A spectral condition for strong stability of non-autonomous linear equation*
Minh Van Nguyen, University of West Georgia, USA

MS8 Numerical Methods for Incompressible Flow Problems - Part I of II(Abstracts on page 25)

9:00 -11:00 AM, March 24
Room: Shelby Center 150 - 1st Floor
For part II, see MS26

Organizers: Leo Rebholtz and Hyesuk Lee, Clemson University, USA

9:00-9:30 AM *A Finite Element Discretization of the Stream-function-Vorticity Formulation of the Quasi-Geostrophic Equations*
Zhu Wang, Virginia Tech, USA

9:30-10:00 AM *Two kinds of 2nd order IMEX methods for Stokes-Darcy system*

Dong Sun, Department of Scientific Computing, Florida State University

10:00-10:30 AM *An adaptive approach to PDE-constrained optimization for random data identification problems*
Clayton Webster, Oak Ridge National Laboratory

10:30-11:00 AM *Covolume-Upwind Finite Volume Approximations for Linear Elliptic Partial Differential Equations*
Lili Ju, University of South Carolina, USA

MS9 Computational Tools and Quantitative Methods for High Dimensional Data Analysis - Part I of II (Abstracts on page 26)
9:00 -11:00 AM, March 24
Room: Shelby Center 103 - First Floor
For Part II, see MS14

Organizers: Don Hong and John Wallin Middle Tennessee State University, USA

9:00-9:30 AM *Model-Based Methods for Analyzing NGS Data*
Peter Meng Zhao, Emory University

9:30-10:00 AM *Unsupervised fMRI Data analysis using graph-based visualizations of self-organizing maps,*
Santosh Katwal, Vanderbilt University, USA

10:00-10:30 AM *Multi-resolution Analysis Method for IMS Data Biomarker Selection and Classification*
Lu Xiong, Middle Tennessee State University, USA

10:30-11:00 AM *Deriving protein inventories from tandem mass spectra*
Dave Tabb, Vanderbilt University, USA

CS1: Contributed Session I (Abstracts on page 27)
9:00-11:00 AM, March 24
Room: Shelby Center 219 - Second Floor

Chair: Goran Lesaja, Georgia Southern University, USA

9:00-9:30 AM *Pseudo-twins and isomorphic subgraphs*
Hua Wang and Stephan Wagner, Georgia Southern University, USA

9:30-10:00 AM *Opial type Diamond-Alpha Dynamic Inequalities and Applications*
Billur Kaymakcalan, Cankaya University, Turkey

10:00-10:30 AM *Some Computational Challenges in Analyzing Global Dynamics of Certain Nonlinear Discrete Dynamical Systems*
Sukanya Basu, Grand Valley State University, USA

10:30-11:00 AM *Infeasible Full-Newton-Step Interior-Point Method for Linear Complementarity Problems*
Goran Lesaja, Georgia Southern University, USA

Coffee Break
11:00 AM - 11:30 AM, March 24
Shelby Center Lobby

IP2 Plenary Talk: What Do Mosquitofish, Shrimp and Proliferating CD4+ T-Cells Have in Common? (Abstracts on page 27)
H.T. Banks, North Carolina State University, USA
SC 107 - 1st Floor
Chair: S.S. Ravindran, University of Alabama in Huntsville
11:30 AM - 12:15 PM, March 24

12:15 PM - 1:15 PM, March 24
Lunch Break
Shelby Center Lobby -1st Floor

Concurrent Sessions: 1:15-3:15 PM

MS10 Recent Advances in Computational and Stochastic Methods in Fluid Dynamics with Control and Estimations - Part II of II
(Abstracts on page 28)
1:15-3:15 PM, March 24
Room: Shelby Center 158 - First Floor
For part I, see MS2

Organizers:
Meng Xu, Rockefeller University, USA
Pani Fernando, Center for Decision, Risk, Controls and Signal Intelligence, Naval Postgraduate School, USA
Sakthivel Kumarasamy, Center for Decision, Risk, Controls and Signal Intelligence, Naval Postgraduate School, USA

1:15-1:45 PM *A Bayesian approach to data assimilation in hemodynamics*
Marta D'Elia, Florida State University, USA

1:45-2:15 PM *Martingale Solutions for Stochastic Navier-Stokes Equations with Ito-Levy Noise*
Sakthivel Kumarasamy and S.S. Sritharan, Naval Postgraduate School, USA

2:15-2:45 PM *Numerical solution of ice-sheets dynamics*
Mauro Perego, Florida State University, USA

2:45-3:15 PM *Manipulation of Micro-Particles Suspended in Fluids Using Vibrating Cilia*
Scott David Kelly, University of North Carolina at Charlotte, USA

MS11 Discontinuous Galerkin Methods - Part I of II (Abstracts on page 28)
1:15-3:15 PM, March 24
Room: Shelby Center 207 - Second Floor
For part II, see MS31

Organizer: Li-yeng Sung
Louisiana State University, USA

1:15-1:45 PM *HDG Methods for the Vorticity-Velocity-Pressure Formulation of the Stokes Problem*
Jintao Cui, IMA, University of Minnesota, USA.

1:45-2:15 PM *Analysis of HDG methods for the Oseen and Navier-Stokes equations*
Aycil Cesmelioglu, IMA, University of Minnesota, USA

2:15-2:45 PM *Penalty-Free Discontinuous Galerkin Methods for the Navier-Stokes Equations*
Shirin Sardar, Rice University, USA.

2:45-3:15 PM *Convergence Analysis of an Adaptive Interior Penalty Discontinuous Galerkin Method for the Helmholtz Equation*
Natasha Sharma, University of Houston, USA.

MS12: Modeling and Dynamics of Networks and Cancer Growth and Invasion (Abstracts on page 29)
1:15-3:45 PM, Saturday, March 24
Room: Shelby Center 150 - 1st Floor

Organizer: Hassan Fathallah-Shaykh
University of Alabama in Birmingham

1:15-1:45 PM *Perturbation Control in Genetic Regulatory Networks*
Nidhal Bouynaya, University of Arkansas, USA

1:45-2:15 PM *Calibration of growth models for metastasis to the lung*
Thierry Colin, University of Bordeaux, France

2:15-2:45 PM *Global asymptotic Stability of a Model of Biological networks*
Hassan Fathallah-Shaykh and Abraham Freiji, University of Alabama in Birmingham, USA

2:45-3:15 PM *Modeling of the response to a treatment for metastasis to the liver of a GIST*
Thierry Colin, University of Bordeaux, France

3:15-3:45 PM *Theory and Experimental Results on 2-element Negative Loops*
Abraham Freiji and Hassan Fathallah-Shaykh, University of Alabama in Birmingham, USA

MS13 Modeling Complex Biological Systems: Theoretical and Computational Studies - Part I of III (Abstracts on page 31)
1:15-3:15 PM, Saturday, March 24
Room: Shelby Center 219 - Second Floor

For part II, see MS24
Organizers:
Xingzhou Yang, Mississippi State University, USA
Shan Zhao, University of Alabama at Tuscaloosa, USA

Abstract:
Studying biological systems by mathematical modeling has been emerging as one of the most intensively studied interdisciplinary research areas in recent years. However the complexity of the biological systems brings new challenges in mechanical and mathematical modeling. This mini-symposium will focus on recent advances on a variety of modeling techniques for different biological systems, and computational and theoretical efforts in solving the problems.

1:15-1:45 PM *Modeling the Transmission Dynamics of Antibiotic Resistant Bacteria in Hospitals*
Shigui Ruan, University of Miami, USA

1:45-2:15 PM *Spatiotemporal Mutualistic Model of Mistletoes and Birds*
Junping Shi, College of William and Mary, USA

2:15-2:45 PM *Effects of Fluid Dynamics on Bacterial Disinfection*
Nick Cogan, Florida State University, USA

2:45-3:15 PM *Fast simulations of pseudo-time coupled nonlinear biomolecular solvation systems*
Shan Zhao, University of Alabama, Tuscaloosa, USA

MS14 Computational Tools and Quantitative Methods for High Dimensional Data Analysis - Part II of II (Abstracts on page 32)
For part I, see MS9
1:15-3:15 PM, March 24
Room: Shelby Center 103 - 1st Floor

Organizers: Don Hong and John Wallin
Middle Tennessee State University, USA

1:15-1:45 PM *Imaging-Driven Mathematical Modeling of Tumor Growth and Treatment Response*
Thomas Yankeelov, Vanderbilt University, USA

1:45-2:15 PM *Computational Imaging Approaches for Quality Assurance in Diffusion Tensor Imaging*
Carolyn Lauzon, Vanderbilt University, USA

2:15-2:45 PM *A hierarchical group ICA model for estimating temporal and spatial patterns of brain networks*
Ying Guo, Emory University, USA

2:45-3:15 PM *Visualizing Global Cluster-Compressed Multivariable and Multi-altitude Atmospheric Data*
Daniel B. Carr, George Mason University, USA

3:15-3:45 PM *Feature selection by support vector machines*
Qiang Wu, Middle Tennessee State University, USA

MS15 Advances in Inverse Problems - Part I of II (Abstracts on page 33)

1:15-3:15 PM, March 24
Room: Shelby Center 105 1st Floor
For part II, see MS20
Organizers: Ian Knowles and Rudi Weikart
University of Alabama in Birmingham, USA

1:15-1:45 PM *An image method for a sphere in an acoustic wave-guide*
Robert Gilbert and Doo-Sung Lee, University of Delaware, USA

1:45-2:15 PM *Active manipulation of fields and applications*
Daniel Onofrei, University of Houston, USA

2:15-2:45 PM *Optimal Source in Diffuse Optical Tomography*
Taufiquar Khan, Clemson, University, USA

2:45-3:15 *Inverse scattering for a left-definite problem*
Rudi Weikard, University of Alabama at Birmingham, USA; Christer Bennewitz, Lund University and Malcolm Brown, Cardiff University, U.K

MS16 Applied and Computational Harmonic Analysis - Part II of III (Abstracts on page 34)

1:15- 3:15 PM, March 24
Room: Shelby Center 216 - 2nd Floor
For part III, see MS30

Organizer:
Alexander Powell, Vanderbilt University, USA

1:15-1:45 PM *Lightening the Load: Low Complexity Discrete Energy Problems with Varying Weights*
Douglas Hardin, Vanderbilt University

1:45-2:15 PM *Geometric Optimization of Finite Unit-Norm Tight Frames* Nathaniel Strawn, Duke University

2:15-2:45 PM *GPU Accelerated Greedy Algorithms for Compressed Sensing*
Jeffrey Blanchard, Grinnell College, USA

2:45-3:15 PM *Consistent signal reconstruction and the geometry of some random polytopes*
J. Tyler Whitehouse, Vanderbilt University, USA

MS17: Generalized Finite Element Methods for PDEs (Abstracts on page 34)

1:15-3:15 PM, March 24
Room: Shelby Center 121 - 1st Floor

Organizers: Susanne C. Brenner and Chris Davis
Louisiana State University, Baton Rouge, USA

Abstract: The generalized finite element method (GFEM) is a Galerkin method in which the shape functions are constructed using a partition of unity and some local approximation functions. In this minisymposium we will discuss aspects of the generalized finite element method such as error analysis, choice of approx- imation functions, issues regarding implementation, and numerical examples. Other numerical schemes such as meshless methods and isogeometric methods may also be discussed here.

1:15-1:45 PM *Mapping Techniques for Isogeometric Analysis of Elliptic Boundary Value Problems Containing Singularities*
Hyunju Kim, University of North Carolina at Charlotte, USA

1:45-2:15 PM *A Generalized Finite Element Method for the Displacement Obstacle Problem of Clamped Kirchoff Plates,*
Susanne C. Brenner, *Chris Davis*, Li-Yeng Sung, Louisiana State University, USA

2:15-2:45 PM *Patchwise Reproducing Polynomial Particle Method for Three-Dimensional Elliptic Boundary Value Problems with Singularities*
Hae-Soo Oh, University of North Carolina at Charlotte, USA

2:45-3:15 PM *Higher Order Stable Generalized Finite Element Method*
Uday Banerjee, Syracuse University, USA

CS2: Contributed Session II (Abstracts on page 36)

1:15-3:15 PM, March 24
Room: Shelby Center 218 - Second Floor
Chair: Bobby Philip, Oak Ridge National Laboratory, USA

1:15-1:45 PM *The Discrete Agglomeration Model: Equivalent Problems*
James Moseley, West Virginia University, USA

1:45-2:15 PM *Matched Filter for a Chaotic Differential Equation*
Ned Corron, U.S. Army RDECOM, USA

2:15-2:45 PM *Non-autonomous Boolean chaos in a driven ring oscillator*
Jonathan Blakely, U. S. Army Aviation and Missile Res., Dev. and Eng. Center, USA

2:45-3:15 PM *3D Structured Adaptive Mesh Refinement and Multilevel Preconditioning for Non-Equilibrium Radiation Diffusion*
Bobby Philip, Oak Ridge National Laboratory, USA

CS3: Contributed Session III (Student Presentations)(Abstracts on page 37)

1:15-3:15 PM, March 24
Room: Shelby Center 205 -Second Floor
Chair: Boris Kunin
University of Alabama in Huntsville, USA

1:15-1:45 PM *Inversion of quasi-separable Vandermonde-like matrices via displacement operator*
Sirani Perera and Vadim Olshevsky, University of Connecticut, USA

1:45-2:15 PM *Multivalued attractors, implicit Euler schemes and the Navier-Stokes equations*
Michele C. Zelati, Indiana University, USA

2:15-2:45 *Positive Stationary Solutions and Spreading Speeds of KPP Equations in Locally Spatially Inhomogeneous Media*
Liang Kong, Auburn University, USA

2:45-3:15 PM *Multi-GPU Solutions of Hyperbolic and Elliptic PDEs with RBF-FD*
Evan F Bollig, Florida State University, USA; Gordon Erlebacher, Florida State University, USA; Natasha Flyer, Florida State University, USA

Coffee Break
3:15 PM - 3:45 PM, March 24
Shelby Center Lobby - 1st Floor

3:45 PM - 5:45 PM, March 24
Concurrent Sessions

MS18: Recent Advances in Analysis of Partial Differential Equations - Part II of III(Abstracts on page 37)
3:45 PM- 6:15 PM, March 24
Room: Shelby Center 121 - 1st Floor
For Part III, see MS28

Organizers:
Emmanuele DiBenedetto, Vanderbilt University, USA
Ugo Gianazza, University of Pavia, Italy

3:45-4:15 PM *Self similar solutions in certain very degenerate parabolic equations*
Marianne Korten, Kansas State University, USA

4:15-4:45 PM *Equilibria and Stability of the Axisymmetric Surface Diffusion Flow*
Jeremy LeCrone, Vanderbilt University, USA

4:45-5:15 PM *A Harnack-type Inequality for a logarithmically singular parabolic equation*
Naian Liao, Emmanuele DiBenedetto, Vanderbilt University, USA; Ugo Gianazza, University of Pavia, Italy

5:15-5:45 PM *Generalizations of p-Laplace equations*
Gary Lieberman, Iowa State University, USA

5:45-615 PM *Compressible Navier-Stokes Equations with Temperature Dependent Heat Conductivity*
Ronhua Pan, and W. Zhang, Georgia Institute of Technology, USA

MS19 Recent Advances in Numerical PDEs and Computational Biology - Parts II of III(Abstracts on page 38)

3:45-5:45 PM, March 24
Room: SC218 - 2nd Floor

For part III, see MS33
Organizers: Lili Ju and Xinfeng Liu, University of South Carolina, USA

3:45-4:15 PM *A fast two-step finite difference method for two-dimensional space-fractional diffusion equations*
Hong Wang, University of South Carolina, USA

4:15-4:45 PM *Intermittent diffusion for global optimizations* Haomin Zhou, Georgia Institute of Technology, USA

4:45-5:15 PM *Pattern Formation on Spheroidal Surfaces and their Finite Element Approximation*
Amnon J. Meir, Auburn University, USA

5:15-5:45 PM *Recent Development of Hierarchical Reconstruction for Limiting on DG and Finite Volume Schemes*
Yingjie Liu, Georgia Institute of Technology, USA

MS 20 Advances in Inverse Problems - Part II of II(Abstracts on page 39)
3:45-5:45 PM, March 24
Room: Shelby Center 158 1st Floor
For part I, see MS15

Organizer: Ian Knowles and Rudi Weikart
University of Alabama in Birmingham, USA

3:45-4:15 PM *Spectral properties of the Lax operator for the matrix nonlinear Schrodinger system*
Martin Klaus, Virginia Polytechnic and State University, USA

4:15-4:45 PM *Stability of the inverse resonance problem on the whole line*
Matthew Bledsoe, University of Alabama at Birmingham, USA

4:45-5:15 PM *The inverse volatility problem for American options*
Ian Knowles and Ajay Mahato, University of Alabama at Birmingham

MS21 Modeling, Simulation, and Analysis of Phase-field Method in Various Science Fields of Current Interests - Part II of III
(Abstracts on page 40)
3:45-5:45 PM, March 24
Room: Shelby Center 203 - Second Floor
For part III, see MS34
Organizer: Xiaofeng Yang
University of South Carolina, USA

3:45-4:15 PM *Phase field method for biological micro-structures*
Xiaoqiang Wang, Florida State University, USA

4:15-4:45 PM *Mathematical Analysis and Diffusive Interface Modeling of Membrane Movements*
Rolf Ryham, Forham University, USA

4:45-5:15 PM *A phase field model for moving contact lines and its application to electrowetting*
Abner J Salgado, University of Maryland, USA Tianyu Zhang,, Montana State University, USA

5:15-5:45 PM *Global regularity and stability of a hydrodynamic system modeling vesicle and fluid interactions* Xiang Xu, Carnegie Mellon University, USA

MS22 Structural and Extremal Graph Theory (Abstracts on page 41)
3:45-5:45 PM, March 24
Room: Shelby Center SC 216 - 2nd Floor
Organizer: Xingxing Yu, Georgia Institute of Technology, USA

3:45-4:15 PM *Linear Choosability of Sparse Graphs*
Gexin Yu, College of William and Mary, USA

4:15-4:45 PM *The Minimum Randic Index of Cyclic Graphs with K Pendant Vertices*
Jeffrey Pair, Middle Tennessee State University, USA

4:45-5:15 PM *On Maximum Edge Cuts of Connected Digraphs*
Guantao Chen, Georgia State University, USA

5:15-5:45 PM *Nowhere-zero 3-flows of Graphs and Odd Edge Cuts*
Rong Luo, Middle Tennessee State University, USA

5:45-6:15 PM *(5,2)-configuration on minimum degree at least two K1,6-free graphs*
Chun-Hung Liu, Georgia Tech, USA

MS23 Asymptotic Dynamics of Dissipative Evolution Equations - Part II of III(Abstracts on page 42)
3:45-5:45 PM, March 24
Room: Shelby Center 205 - Second Floor
For part III, See MS35
Organizers: Wenzhang Huang, University of Alabama in Huntsville and Wenxian Shen, Auburn University

3:45-4:15 PM *Traveling water waves with compactly supported vorticity*
Chongchun Zeng, Georgia Institute of Technology, USA

4:15-4:45 PM *Shape memory alloys, antidiffusion lattice equations, and traveling checkerboards*
Erik Van Vleck, University of Kansas, USA

4:45-5:15 PM *Up-scaling chaotic dynamics in porous media via central limit theorems*
Moongyu Park, University of Alabama in Huntsville, USA; J.H. Cushman, Purdue University, USA

5:15-5:45 *Evolution of Mixed Dispersal in Periodic Environments*
Wenxian Shen, Auburn University, USA; Chiu-Yen Kao and Yuan Lou, Ohio State University, USA

MS24 Modeling Complex Biological Systems: Theoretical and Computational Studies - Part II of III(Abstracts on page 43)
3:45-6:15 PM, March 24
Room: Shelby Center 219 - Second Floor

For part III, see MS32
Organizers: Xingzhou Yang, Mississippi State University, USA and Shan Zhao, University of Alabama at Tuscaloosa, USA

3:45-4:15 PM *Multiphase modeling of hydrogels and its application to bacterial biofilms*
Qi Wang, University of South Carolina, USA

4:15-4:45 PM *Generalized image charge solvation model for electrostatic interactions in molecular dynamics simulations of aqueous solutions*
Shaozhong Deng, UNC, Charlotte, USA

4:45-5:15 PM *An agent-based model of mosquito host localization through odor plume finding and tracking*
Bree Cummins, Tulane University, USA

5:15-5:45 PM *WENO computations and pattern formation of a chemotactic cell movement model*
Yong-Tao Zhang, University of Notre Dame, USA

5:45-6:15 PM *Mathematical Model for Two Germline Stem Cells Competing for Niche Occupancy*
Jianjun Paul Tian, College of William and Mary, USA; Zhigang Jin and Ting Xie, Stowers Institute for Medical Research, USA

MS25 High order numerical approximations to partial differential equations(Abstracts on page 44)
Organizer: Cheng Wang, University of Massachusetts at Dartmouth, USA
3:45-5:45 PM, March 24
Room: Shelby Center 207 - Second Floor

3:45-4:15 PM *A partition of unity radial basis function collocation method for partial differential equations*
Alfa Heryudono, University of Massachusetts Dartmouth, USA; Elizabeth Larsson, Uppsala University, Sweden.

4:15-4:45 PM *Global in time numerical stability of pseudo-spectral schemes for nonlinear PDEs*
Cheng Wang and Sigal Gottlieb, University of Massachusetts Dartmouth, USA

4:45-5:15 PM *Determining Critical Parameters of Sine-Gordon and Nonlinear Schrodinger Equations with a Point-Like Potential Using Generalized Polynomial Chaos Methods*
Jae-Hun Jung, Debananda Chakraborty and Emmanuel Lorin, SUNY at Buffalo, USA

5:15-5:45 PM *First and Second Order Unconditionally Energy Stable Schemes for the Nonlocal Cahn-Hilliard and Allen-Cahn Equations*
Zhen Guan, University of Tennessee, USA; Cheng Wang, University of Massachusetts Dartmouth and Steven Wise, University of Tennessee, USA

MS26 Numerical Methods for Incompressible Flow Problems - Part II of II(Abstracts on page 45)
3:45 -5:45 PM, March 24
Room: Shelby Center 150 -1st Floor
For part I, see MS8
Organizers: Leo Rebholtz and Hyesuk Lee, Clemson University, USA

3:45-4:15 PM *Approximation of viscoelastic fluid flows with defective boundary conditions*
Keith Galvin, Clemson University, USA

4:15-4:45 PM *Numerical approximations of the Voigt regularization of incompressible Navier-Stokes and magnetohydrodynamics equations*
Nick Wilson, Clemson University, USA

4:45-5:15 PM *A variational approach for image-based parameter estimation in hemodynamics*
Luca Bertagna, Emory University, USA

5:15-5:45 PM *A parallel fast solver for the 3-D Helmholtz integral operator in layered media*
Min Hyung Cho, The University of North Carolina at Charlotte, USA

MS27 Advances in Free Boundary Problems - Part I of II(Abstracts on page 46)
3:45-5:15 PM. March 24
Room: Shelby Center 105 - 1st Floor
For part I, see MS4
Organizer: Shawn Walker, Louisiana State University
Abstract: This mini-symposium will explore recent advancement in the mathematical modeling and numerical analysis/scientific computation of a variety of problems that exhibit moving interfaces. Discussion will range from modeling issues to numerical analysis of the computational methods. Application areas include multi-physics applications, phase-field methods, optimal control, fluid-structure interaction, non-Newtonian flows, dynamic meshing, as well as methods for computing with moving interfaces.

3:45-4:15 PM *A Lagrangian method for low Reynolds number viscoelastic flow*
Bree Cummins, Tulane University, USA

4:15-4:45 PM *Some simple techniques for the level-set interface capturing with the BFECC method*
Yingjie Liu, Georgia Tech, USA

4:45-5:15 PM *Operator splitting methods for stiff convection-reaction-diffusion equations*
Xinfeng Liu, University of South Carolina, USA

CS4: Contributed Session IV(Abstracts on page 46)
3:45-6:15 PM, March 24
Room: Shelby Center 103 - 1st Floor
Chair: Patricio Vela, Georgia Tech

3:45-4:15 PM *Shadow Densities for Speeding the Execution and Evaluation of Kernel Machines*
Patricio Vela and Hassan Kingravi, Georgia Institute of Technology, USA

4:15-4:45 PM *A Continuous Model for Gene Flow*
Michal Palczewski, Florida State University, USA

4:45-5:15 PM *A Discrete Regularity Result for a Linear Scheme for the Saturation Equation*
Koffi Fadimba, University of South Carolina at Aiken, USA

5:15-5:45 PM *Modeling financial markets with infinite dimensional stochastic systems*
Flavia C. Sancier-Barbosa, Witteberg University, USA

5:45-6:15 PM *Most Likely Path to the shortfall risk in Long-Term Hedging with Short-Term Futures Contracts*
Jing Chen, University of Alabama in Tuscaloosa, USA

6:30 PM - 8:00 PM, March 24
Dinner Break
University Center, Room 100 (Exhibit Hall)

Registration: 8:00 - 8:30 AM, Sunday, March 25
Shelby Center Lobby

IP3 Plenary Talk: Finite Element Methods for a Fourth Order Obstacle Problem(Abstracts on page 47)
Susanne C. Brenner, Louisiana State University, USA
8:30 AM - 9:15 AM, March 25
Chair: S.S. Ravindran, University of Alabama in Huntsville
SC107 - 1st Floor

9:15 AM - 9:45 AM, March 25
Coffee Break
Shelby Center Lobby - 1st Floor

9:45 AM - 11:45 AM
Concurrent Sessions

MS28 Recent Advances in Analysis of Partial Differential Equations - Part III of III(Abstracts on page 48)

9:45 AM - 11:45 AM, March 25
Room: Shelby Center 121 - 1st Floor
For Part II, see MS18

Organizers: Emmanuele DiBenedetto, Vanderbilt University, USA; Ugo Gianazza, University of Pavia, Italy

9:45-10:15 AM *Stationary Navier-Stokes Equations With Critically Singular External Forces: Existence and Stability Results*
Phuc Nguyen and Tuc Van Phan, Louisiana State University, USA

10:15-10:45 AM it On Well-posedness of Incompressible Two-phase Flows with Phase Transitions
Gieri Simonett, Vanderbilt University, USA

10:45-11:15 AM *Local Holder Continuity for Doubly Nonlinear Parabolic Equations*
Jose Miguel Urbano, Tuomo Kuusi and Juhana Siljander, Universidade de Coimbra, Portugal

11:15-11:45 AM *On Positive Solutions of Quasi-linear Elliptic Equations Involving Critical Sobolev Growth*
Henghui Zou, University of Alabama in Birmingham, USA

MS29 Computational Accelerators - Algorithms on Non-traditional Hardware(Abstracts on page 49)
9:45-11:45 AM, March 25
Room: Shelby Center 103 - 1st Floor

Organizer: R. Phillip Bording, Wave Research, USA

Abstract:
The advent of the Sony PlayStation as a compute engine rather than a gaming console is an example of a non-traditional computing device. The development of powerful Graphics Processing Units (GPU'S) again for the gaming community has created a single chip with hundred's of floating point computational units. The time-to-market field programmable gate array (FPGA's) has millions of logic gates that can be organized into computing structures. Algorithm mappings into FPGA's are challenging and very interesting areas of current research. In both cases the use of these many arithmetic units leads to computational acceleration. This session is designed to bring these exciting new technologies to the forefront of our research communities.

9:45-10:15 AM *Solving the Heat Equation using the Finite Element Method and Field Programmable Gate Arrays*
Andy Scott, Alabama A and M University and it Phil Bording, Wave Research, USA

10:15-10-45 AM *Image Processing using Field*

Programmable Gate Arrays
Shealia Burton, Alxavier Peebles, Jennifer Little, Rachel Hall, Shealia Burton, Kendon Lane, Andy Scott, and K. Heidary, Alabama A and M University; Phil Bording, Wave Research, USA

10:45-11:15 AM *Applying a Genetic Algorithm to Reconfigurable Hardware using a Traditional HDL Approach*
Jessica Mintz and *B. Earl Wells*, University of Alabama in Huntsville, USA

11:15-11:45 AM *Space Weather Phenomena Simulation using a Graphics Processing Unit*
Patrick Gilbert, Scotty Bridges, Jason Schansman, Frank Richard, *Nagendra Singh*, and B. Earl Wells, University of Alabama in Huntsville, USA

MS30 Applied and Computational Harmonic Analysis - Part III of III(Abstracts on page 49)

9:45-11:45 AM, March 25
Room: Shelby Center 216 - 2nd Floor
For part I, see MS3

Organizer:
Alexander Powell, Vanderbilt University, USA

9:45-10:15 AM *Necessary and Sufficient Conditions to Perform Spectral Tetris*
Peter Casazza, University of Missouri, USA

10:15-10:45 AM *A Time-Frequency Localization Measure for Finite Frames*
Mark Lammers, University of North Carolina at Wilmington, USA

10:45-11:15 AM *Gabor frames in amalgam spaces*
Ilya Krishtal, Northern Illinois University, USA

11:15-11:45 AM *Almost sure convergence for the Kaczmarz algorithm with random measurements*
Xuemei Chen, Vanderbilt University, USA

MS31 Discontinuous Galerkin Methods - Part II of II(Abstracts on page 50)

9:45-11:45 AM, March 25
Room: Shelby Center 207 - Second Floor
For part I, see MS11

Organizer: Li-yeng Sung, Louisiana State University, USA

9:45-10:15 AM *An analysis of the practical DPG method*
Weifeng Qiu, IMA, University of Minnesota, USA.

10:15-10:45 AM *Domain decomposition preconditioners for the discontinuous Petrov-Galerkin method*
Andrew Baker, Louisiana State University, USA.

10:45-11:15 AM *A nonoverlapping domain decomposition preconditioner for a symmetric interior penalty Galerkin method*
Eun-Hee Park, Louisiana State University, USA.

11:15-11:45 AM *A Morley Finite Element Method for the Displacement Obstacle Problem of Clamped Kirchhoff Plates*
Yi Zhang, Louisiana State University, USA.

MS32 Modeling Complex Biological Systems: Theoretical and Computational Studies - Part III of III(Abstracts on page 51)

9:45-11:45 AM, March 25
Room: Shelby Center 219 - Second Floor

For part I, see MS13

Organizers: Xingzhou Yang, Mississippi State University, USA and Shan Zhao, University of Alabama at Tuscaloosa, USA

9:45-10:15 AM *CFD Prediction of Air Flow and Particle Transport in Large-Scale Human Lung Models*
Keith Walters, Mississippi State University, USA

10:15-10:45 AM *Treecode-Accelerated Boundary Integral Poisson-Boltzmann Solver*
Weihua Geng, University of Alabama, Tuscaloosa, USA

10:45-11:15 AM *Computational studies for cell signaling with scaffold*
Xinfeng Liu, University of South Carolina, USA

11:15-11:45 AM *Multiscale Model of Mucus Penetration in the Lung*
Xingzhou Yang, Mississippi State University, USA; Lisa Fauci Tulane University, USA; Robert Dillon Washington State University, USA

MS33: Recent Advances in Numerical PDEs and Computational Biology - Part III of III(Abstracts on page 52)

9:45-11:45 AM, March 25
Room: SC218 - 2nd Floor

For part I, see MS5

Organizer: Lili Ju and Xinfeng Liu, University of South Carolina, USA

9:45-10:15 AM *A Two Level Additive Schwarz Preconditioner for C^0 Interior Penalty Methods for Cahn-Hilliard Equation*
Kenning Wang, University of North Florida, USA

10:15-10:45 AM *Time dependent problem of porous media with nonlinear permeability*
Song Chen –Student Speaker, Auburn University, USA

10:45-11:15 AM *Error Analysis of a Stochastic Collocation Method for Parabolic Partial Differential Equations with Random Input Data*
Guannan Zhang –Student Speaker, Florida State University, USA

11:15-11:45 AM *Forward Backward Doubly Stochastic Differential Equations and applications to The Optimal Filtering problem*
Bao Feng – Student speaker, Auburn University, USA

MS34 Modeling, Simulation, and Analysis of Phase-field Method in Various Science Fields of Current Interests - Part III of III
(Abstracts on page 53)
9:45-11:45 AM, March 25
Room: Shelby Center 203 - Second Floor

For part I, see MS6

Organizer: Xiaofeng Yang, University of South Carolina, USA

9:45-10:15 AM *A comparison study of phase-field models for an immiscible binary mixture with surfactant*
Ana Yun, Korea University, Republic of Korea

10:15-10:45 AM *The self-similar evolution of a precipitate in elastic media*
Amlan Barua, University of Illinois at Chicago, USA

10:45-11:15 AM *Phase-field simulations of dynamic wetting of viscoelastic fluids*
Pengtao Yue, Virginia Tech, USA

11:15-11:45 AM *Unconditionally pseudo-energy stable numerical schemes for the modified phase field crystal (MPFC) equation*
Cheng Wang, UMass at Dartmouth, USA

MS35 Asymptotic Dynamics of Dissipative Evolution Equations - Part III of III (Abstracts on page 54)

9:45-11:45 AM, March 25
Room: Shelby Center 205 - Second Floor

For part I, See MS23

Organizers: Wenzhang Huang, University of Alabama in Huntsville and Wenxian Shen, Auburn University

9:45-10:15 AM *Convergence versus periodicity in single-loop positive-feedback systems arising in the study of higher-order elliptic PDEs*
Paul G. Schmidt, Auburn University, USA; Monica Lazzo, University di Bari, Italy

10:15-10:45 AM *Global dynamics of a mathematical model for malaria transmission*
Shangbing Ai, University of Alabama in Huntsville, USA

10:45-11:15 AM *Principal Eigenvalues of Dispersal Operators and Their Applications*
Aijun Zhang, University of Kansas, USA

11:15-11:45 AM *Traveling Wave Solutions for a Class of Predator-Prey Systems*
Wenzhang Huang, University of Alabama in Huntsville, USA

MS36 Peridynamics: Material Modeling Without Derivatives (Abstracts on page 55)

9:45-11:45 AM, March 25
Room: Shelby Center 150 - First Floor

Organizer: Steven F. Henke, Florida State University, USA
Abstract: Peridynamics is a recently-developed reformulation of solid mechanics that is non-local and avoids spatial derivatives, using an integral approach instead. Thus, it is suitable for modeling phenomena involving discontinuities, including cracking and fracture. In this minisymposium, speakers will address analytical and computational issues pertinent to peridynamics or related non-local models.

9:45-10:15 AM *Well-posedness of the Linear Peridynamic Model of Continuum Mechanics*
Tadele Mengesha, Penn State University, USA

10:15-10:45 PM *Finite Element Methods for Peridynamics: A Tale of Many Quadratures*
Miroslav Stoyanov Oak Ridge National Laboratory, USA

10:45-11:15 PM *Numerical Methods for the Nonlocal Peridynamics Model*
Xi Chen, Florida State University, USA

11:15-11:45 AM *Convergence and Scaling of a Peridynamic Diffusion Equation In Multiple Dimensions*
Steven F. Henke, Florida State University, USA

MS37: Mathematical Modeling in Biomedicine(Abstracts on page 56)

9:45-11:45 AM, March 25
Room: Shelby Center 105 - First Floor

Organizer: Michele L. Joyner, East Tennessee State University, USA

9:45-10:15 AM *Modeling and Optimal Control of Immune Response of Renal Transplant Recipients Shuhua Hu*, H.T. Banks, North Carolina State University, USA; Taesoo Jang and Hee-Dae Kwon, Inha University, Rebublic of Korea.

10:15-10:45 AM *Using Mathematical Modeling to Assess the Efficacy of Oxygen for Problem Wounds: Use of Hyperbaric or Topical Oxygen Therapies Richard Schugart*, Western Kentucky University, USA; Jennifer Flegg, D.L.S. McElwain, Queensland University of Technology, Australia.

10:45-11:15 AM *A Consensus Model for Electroencephalogram Data Via the S-Transform Andrew Young*, Jeff Knisley, East Tennessee State University, USA.

11:15-11:45 AM *Modeling the Effects of a New Class vs. Next Generation Antibiotic on the Spread of Antimicrobial Resistance in a Hospital Setting Michele L. Joyner*, East Tennessee State University, USA.

CS5: Contributed Session V(Abstracts on page 57)

9:45-11:45 AM, March 25
Room: Shelby Center 158 - 1st Floor

Chair: Fengqi Yi, Harbin Engineering University, China

9:45-10:15 AM *Pattern Formation induced by delay and diffusion in a Schnakenberg system with gene expression*
Fengqi Yi, Harbin Engineering University, China

10:15-10:45 AM *A Comparative Study of Variational Iteration Method and Laplace Homotopy Perturbation Method* H.K. Mishra, Jaypee University of Engineering and Technology, India

10:45-11:15 AM *A potential-based finite element scheme with CGM for eddy current problems* Tong Kang, Communication University of China, China

11:15-11:45 AM *Communication protocols based on CAAA attributes* N. Vijayarangan, Tata Consultancy Services Limited, India

Lunch Break
University Center, Room 100
11:45 AM - 1:30 PM, March 25

IP4 Plenary Talk:**Searching for Diamonds** (Abstracts on page 58)
1:30 PM - 2:15 PM, March 25
Jerrold Griggs, University of South Carolina, USA
Chair: S.S. Ravindran, University of Alabama in Huntsville
Shelby Center 107 -1st Floor

Closing Remarks by Patricio Vela, SIAM SEAS President, and Award Ceremony
2:30-3:00 PM, March 25
Shelby Center 107 - 1st Floor

List of Speaker Abstracts

IP1 Plenary Talk: Efficient numerical approaches for the simulation and control of PDEs with random inputs
We discuss three problems involving the numerical solution of PDEs with random inputs. First, we consider an approach for PDEs driven by white noise in which the problem is transformed into one driven by correlated noise which can then be efficiently treated using, e.g., Karhunen-Loeve expansions and sparse grid methods. We then discuss the replacement of white noise forcing with the perhaps more physically relevant pink noise of, more generally, $\frac{1}{f^\alpha}$ noise. We also discussed methods for discretizing these noises. Finally, we discuss methods for treating control and optimization problems constrained by PDEs with random inputs. Collaborators in this work include John Burkardt, Steven Hou, Ju Ming, Miroslav Stoyanov, Catalin Trenchea, and Clayton Webster.
Author Max Gunzburger, Department Scientific Computing, Florida State University, USA

MS1: Recent Advances in Analysis of Partial Differential Equations - Part I of III

On the Inverse Stefan Problem
We develop a new variational formulation of the inverse Stefan problem, where information on the heat flux on the fixed boundary is missing and must be found along with the temperature and free boundary. We employ optimal control framework, where boundary heat flux and free boundary are components of the control vector, and optimality criteria consists of the minimization of the sum of L^2-norm declinations from the available measurement of the temperature flux on the fixed boundary and available information on the phase transition temperature on the free boundary. This approach allows one to tackle situations when the phase transition temperature is not known explicitly, and is available through measurement with possible error. It also allows for the development of iterative numerical methods of least computational cost due to the fact that for every given control vector, the parabolic PDE is solved in a fixed region instead of full free boundary problem. We prove well-posedness in Sobolev spaces framework, Frechet differentiability and convergence of discrete optimal control problems to the original problem both with respect to cost functional and control. This is a joint work with Ogugua Onyejekwe.
Author: Ugur Abdulla, Florida Institute Of Technology, USA

Existence Results for the Non-homogeneous Infinity Laplacian
Let $\Omega \subset \mathbb{R}^N$, $N \geq 2$, be a bounded domain. In this talk, we present recently obtained results on

the existence of viscosity solutions u to

$$\Delta_\infty = \sum_{i,j=1}^{N} D_{ij}uD_iuD_ju = f(x,u) \text{ in } \Omega$$

and $u = g$ on $\partial\Omega$. Here $u \in C(\overline{\Omega})$, $f \in C(\Omega \times \mathbb{R}, \mathbb{R})$ and $g \in C(\partial\Omega)$. We will provide outline of proofs for fairly general f's. A brief discussion of the uniqueness of solutions will also be presented.
Author: Tilak Bhattacharya, Western Kentucky University, USA

Strong Solutions to an Obstacle Problem with Coefficients in VMO
We consider the obstacle problem:

$$a^{ij}D_{ij}w = \chi_w > 0 \text{ in } B_1 \text{ with } w = \psi \text{ on } \partial B_1$$

where we assume that the coefficients a^{ij} belong to VMO, that the functions $w, \psi \geq 0$ belong to the Sobolev space $W^{2,p}$; and that w satisfies the PDE pointwise almost everywhere. We show existence, uniqueness, regularity, and nondegeneracy of the solutions. These results allow us to begin the study of the regularity of the free boundary. In particular, we establish a measure theoretic version of the Caffarelli Alternative after showing a measure stability result for the contact sets. All of these results are joint work with my PhD student, Kubrom Teka.
Author: Ivan Blank, Kansas State University, USA

Logarithmically Singular Parabolic Equations as Limits of the Porous Medium Equation
Let $\{u_m\}$ be a local, weak solution to the porous medium equation

$$u_{m,t} - \Delta w_m = 0$$

where $w_m = \frac{(u_m^m - 1)}{m}$. It is shown that if $\{u_m\}$ is locally in L^r_{loc} for $r > \frac{1}{2}N$ uniformly in m and if w_m is in L^p_{loc} for $p > N + 2$ in the space variables, uniformly in time, then u_m contains a subsequence converging in $C^{\alpha,1/2\alpha}_{loc}$ to a local, weak solution to the logarithmically singular equation $u_t = \Delta lnu$. This is a joint work with Emmanuele DiBenedetto and Naian Liao.
Author: Ugo Gianazza, University of Pavia, Italy

Holder Continuity of a Bounded Weak Solution of Generalized Parabolic p-Laplacian Equations
We introduce the prototype equation of generalized parabolic p-Laplacian type equations

$$u_t - \operatorname{div}\left(\frac{g(|Du|)}{|Du|}\right) = 0\,.$$

where a continuous, nonnegative, increasing function g with $g(0) = 0$. With the function G, the antiderivative of g, we assume that there are constants g_0 and g_1 satisfying $1 < g_0 \leq g_1 < \infty$ such that $g_0\, G(\sigma) \leq \sigma g(\sigma) \leq g_1\, G(\sigma)$ for all $\sigma \geq 0$. Through this generalization in the setting from Orlicz spaces, we provide a uniform proof with a single geometric setting that a bounded weak solution is locally older continuous without separating degenerate and singular types. Stability arguments for parabolic p-Laplacian type equations when p goes to 2 are not needed in our approach. By using geometric characters, our proof does not rely on any of alternatives which is based on the size of solutions. The regularity theory for both degenerate and singular equations is captured by using local and logarithmic energy estimates in an appropriately tailored cylinder.
Author: S. Hwang, Iowa State University, USA

MS2 Recent Advances in Computational and Stochastic Methods in Fluid Dynamics with Control and Estimations - Part I of II

Robust Airfoil Optimization Using Maximum Expected Value and Expected Maximum Value Approaches

Deterministic transonic shape optimization designs can result in dramatically inferior performance when the actual operating conditions are different from the design conditions used during the deterministic optimization procedure. The talk will focus on describing appropriate stochastic optimization approaches that are able to produce robust designs. An application to improve an initial RAE 2822 design will be presented.

Authors: Ana-Maria Croicu, Kennesaw State University , USA; M. Yousuff Hussaini, Florida State University, USA; Antony Jameson, Stanford University, USA; Goetz Klopfer, NASA Ames Research Center, USA

Stochastic Navier-Stokes Equations with Levy Noise

In this work, we study existence and uniqueness of the solution of stochastic Navier-Stokes equation with Ito-Levy noise. Nonlinear filtering problem is formulated for the recursive estimation of conditional expectation of the flow field given back measurement and the corresponding Fujisaki-Kallianpur-Kunita and Zakai equations are derived. Existence and uniqueness of the measure-valued solutions are proven for the filtering equations.

Author: Pani Fernando, Naval Postgraduate School, USA; S.S. Sritharan, Naval Postgraduate School, USA.

An Optimal Control Problem for A Flow of Hamiltonian and Gradient Type in The Space of Probability Measures

We will discuss an optimal control problem in the space of probability measures on $\mathbb{R}^2$. The problem is motivated by a stochastic interacting particle model which gives the 2-D Navier-Stokes equations in their vorticity formulation as mean-field equation. The associated Hamilton-Jacobi-Bellman equation is studied in the space of probability measures. We will introduce an appropriate notion of viscosity solution and show that the value function is the unique solution in this sense.

Andrzej Swiech, Georgia Institute of Technology, USA; Jin Feng University of Kansas, USA; Atanas Stefanov University of Kansas, USA.

Control of Stochastic Heat-Diffusion Systems under Markovian Switching

In this talk, we present a new approach to robustly stabilize a nonlinear stochastic heat diffusion system driven by Wiener fields under Markovian switching. The jump Markovian switching is modeled by a discrete-time finite state Markov chain. Sufficient conditions for stochastic stability are established in the context of Lyapunov-like function techniques coupled with Ito's formula. For such distributed parameter systems, the robustness properties of stochastic asymptotic stability against all admissible uncertainties are also investigated. Examples are given to demonstrate the results.

Authors: Micheal Knap Tennessee State University, USA; Sivapragasam Sathananthan, Tennessee State University, USA.

MS3: Applied and Computational Harmonic Analysis - Part I of III

Frame potentials and the dynamical optimization of frames

Redundant, stable expansions with frames have become central to many applications of mathematics in today's technology. Optimal frames for certain purposes are characterized as minimizers of suitable frame potentials, for example equal-norm or Grassmannian tight frames. Examples of such minimizers have been systematically constructed, for example equiangular tight frames, but after many years of efforts they reside mostly in small dimensions or their construction relies on specific graph-theoretic or group-representation properties. This talk presents an alternative to the conventional, structured design methods; we let frames evolve under flows which drive them towards optimality, instead of constructing them directly. The general objectives are to find appropriate frame dynamics, suitable initializations, and to obtain deterministic control of frame performance measures for certain applications. This talk covers the case of equal-norm tight frames as well as

recent work with Helen Elwood related to the construction of equiangular tight frames.
Authors: Bernhard Bodmann, University of Houston, USA.

Full Spark Frames
Finite frame theory has a number of real-world applications. In applications like sparse signal processing, data transmission with robustness to erasures, and reconstruction without phase, there is a pressing need for deterministic constructions of frames with the following property: every size-M subcollection of the M-dimensional frame elements is a spanning set. Such frames are called full spark frames. We will discuss some properties of the set of full spark frames and provide some constructions of these frames.
Author: Jemeson Cahill, University of Missouri, USA.

High order Fourier analysis of infinite-time quantized frame expansions
The approximation error of quantized finite frames is typically measured using the l_2 or l_∞ norms. With infinite-time frame expansions however, as is the case of bandlimited signal acquisition, only the l_∞-norm is well defined as quantization error signals are not of finite energy. This is problematic as engineers often require a refined spectral analysis of the quantization errors. Historically, this question has been mostly approached by second-moment probabilistic modeling of the quantization noise. A deterministic approach to quantization spectral analysis was introduced by R.M.Gray in the late 80's and was based on the use of finite power in place of finite energy (l_2 norm). While this work was rigorously performed, there is a surprising absence of mathematical background on finite power as a norm, and more specifically as a norm induced by an inner product. In this talk, we construct a rigorous Hilbert space framework for the power spectral analysis of quantization error sequences in the deterministic finite-power sense. We start with the fact that, contrary to finite energy signals, the whole space P of finite power signals is not a Hilbert space, because it is not even linear! One needs to specifically build closed linear subspaces of P to acquire a Hilbert space structure. When a finite sum of sinusoids is quantized by either pulse code modulation (PCM) or Sigma-Delta modulation (including 1-bit overloaded configurations), we show that the resulting quantizer error sequence belongs to the non-separable Hilbert space S spanned by the sequences $e^(i.p[n])$ where $p[n]$ are real polynomials. This property is based on Weyl criterion for equidistribution. In S, quantizer error sequences thus yield orthogonal and high-order Fourier expansions. In any shift-invariant linear subspace of P, including S, the power spectral density of a sequence e is formalized as the Fourier transform of the autocorrelation sequence $r[m] =< e, T^m e >$, where $< \cdot, \cdot >$ is the finite-power inner product and T is the sequence shift operator. Using the property that T is unitary and its specific action on polynomial exponentials, we show that the measure associated with the power spectral density is in general mixed, with a discrete component and a continuous component that is however always absolutely continuous. In the application of Sigma-Delta modulation, we deduce from this the mechanisms of intermodulation, tones, "white noise" and non-white continuous spectra.
Author: N.T. Thao, City College of New York

The road to deterministic matrices with the restricted isometry property
The restricted isometry property (RIP) is a well-known matrix condition that provides state-of-the-art reconstruction guarantees for compressed sensing. While random matrices are known to satisfy this property with high probability, deterministic constructions have found less success. In this talk, we consider various techniques for demonstrating RIP deterministically, and we evaluate their performance.
Author: Dustin Mixon, Princeton University, USA

MS4 Advances in Free Boundary Problems - Part I of II

Optimal Control of a Free Boundary Problem with Second Order Suffcient Optimality Conditions

We consider a PDE constrained optimization problem governed by a free boundary problem. The state system is based on coupling of the Laplace equation in the bulk with Young-Laplace equation on the free boundary to account for surface tension as proposed by P. Saavedra and L. R. Scott. This amounts to solving a second order system both in the bulk and on the interface. Our analysis provides a set of box constraints on control such that the state constraints are always satisfied. Using only first order regularity we show that the control to state operator is twice Frechet differentiable. We demonstrate how to improve the regularity of the state variables up to second order. We show existence of a control with second order sufficient optimality conditions under the enhanced second order regularity. Finally we conclude with the optimal first order of convergence for the control and a few numerical examples.
Author: Harbir Antil, University of Maryland, USA

A Diffuse Interface Model For Electrowetting With Moving Contact Lines
We introduce a diffuse interface model for the phenomenon of electrowetting on dielectric and present an analysis of the arising system of equations. Moreover, we study discretization techniques for the problem. The model takes into account different material parameters on each phase and incorporates the most important physical processes, such as incompressibility, electrostatics and dynamic contact lines; necessary to properly reflect the relevant phenomena. The arising nonlinear system couples the variable density incompressible Navier-Stokes equations for velocity and pressure with a Cahn-Hilliard type equation for the phase variable and chemical potential, a convection diffusion equation for the electric charges and a Poisson equation for the electric potential. Numerical experiments are presented, which illustrate the wide range of effects the model is able to capture, such as splitting and coalescence of droplets.
Author: Abner Salgado, University of Maryland, USA

Multiscale modeling in DNS of multiphase flows
In direct numerical simulations of multiphase flows, we often find small-scale features, such as thin films, filaments, and drops, that are much smaller than the "dominant" flow scales. Usually the geometry of these features is simple and the flow viscous, so they can be described by analytical models. Here we describe recent efforts to combine classical thin film and boundary layer descriptions of small-scale features with direct numerical simulations of the rest of the flow.
Author: Gretar Tryggvason, University of Notre Dame, USA

Tetrahedralization of Isosurfaces with Guaranteed-Quality by Edge Rearrangement (TIGER)
We present a method for generating 3-D unstructured tetrahedral meshes of objects with smooth boundaries. The algorithm is fast, robust, and provides *useful* guaranteed dihedral angle bounds for the output tetrahedra. The method uses a BCC lattice, is simple to implement, and performs *no* extra refinement of the background lattice. The most complicated mesh transformations are 4-4 edge flips. Applications range from free boundary flows, to modeling deformations, shape optimization, and anything that requires dynamic meshing (e.g. virtual surgery).
Author: Shawn Walker, Louisiana State University, USA

MS5: Recent Advances in Numerical PDEs and Computational Biology - Part I of III

Modeling and simulating tumor growth with therapy
We present a few mathematical models for the study of tumor growth, where free boundary problems with nonlinear PDEs are formulated and several tumor treatments are incorporated, including radiotherapy, chemotherapy, and irotherapy. We conduct both numerical simulation and mathematical analysis to gain insight into the complex mechanism of tumor growth. We compare our numerical results to some available experimental measurements, and discuss how to further improve the efficacy of these tumor treatments.
Author: J. Wang, Old Dominian University, USA

Krylov implicit integration factor methods and applications in pattern solutions
Integration factor methods are a class of "exactly linear part" time discretization methods. Recently, a class of efficient implicit integration factor (IIF) methods were developed for solving systems with both stiff linear and nonlinear terms, arising from spatial discretization of time-dependent partial differential equations (PDEs) with linear high order terms and stiff lower order nonlinear terms. The tremendous challenge in applying IIF temporal discretization for PDEs on high spatial dimensions is how to evaluate the matrix exponential operator efficiently. For spatial discretization on unstructured meshes to solve PDEs on complex geometrical domains, how to efficiently apply the IIF temporal discretization was open. In this talk, I will present our results in solving this problem by applying the Krylov subspace approximations to the matrix exponential operator. Then we apply this novel time discretization technique to discontinuous Galerkin (DG) methods on unstructured meshes for solving reaction-diffusion equations. Numerical examples are shown to demonstrate the accuracy, efficiency and robustness of the method in resolving the stiffness of the DG spatial operator for reaction-diffusion PDEs. Application of the method to mathematical models in pattern formation shall be shown.
Author: Y. Zhang, Florida State University, USA

Mathematical modeling for cell-oscillations
In this talk, we build a mathematical model and its phase field formulation for the actomyosin driven cell oscillations. This modeling is based on a mechanism of actin dynamics and symmetry breaking of actin gels around the membrane. We also present and implement some efficient time and spatial discretizations of the proposed model based on the spectral method. Three dimensional numerical simulations are given and compared with real biological experiments.
Author: X. Wang, Florida State University, USA

A Multiscale Method for Epitaxial Growth
We investigate a heterogeneous multiscale method (HMM) for interface tracking and apply the technique to the simulation of epitaxial growth. HMM relies on an efficient coupling between macroscale and microscale models. When the macroscale model is not fully known explicitly or not accurate enough, HMM provides a procedure for supplementing the missing data from a microscale model. Here we design a multiscale method that couples kinetic Monte-Carlo (KMC) simulations on the microscale with the island dynamics model based on the level set method and a diffusion equation. We perform the numerical simulations for submonolayer island growth and step edge evolutions on the macroscale domain while keeping the KMC modeling of the internal boundary conditions. Our goal is to get comparably accurate solutions at potentially lower computational cost than for the full KMC simulations, especially for the step flow problem without nucleation.
Author: Yi Sun, University of South Carolina, USA

MS6 Modeling, Simulation, and Analysis of Phase-field Method in Various Science Fields of Current Interests - Part I of III

The dynamics of two phase complex fluids: drop formation/pinch-off
We present an energetic variational phase-field model for the two-phase Incompressible flow with one phase being the nematic liquid crystal. The model leads to a coupled nonlinear system satisfying an energy law. An efficient and easy-to-implement numerical scheme is presented for solving the coupled nonlinear system. We use this scheme to simulate two benchmark experiments: one is the formation of a bead-on-a-string phenomena, and the other is the dynamics of drop pinching-off. We investigate the detailed dynamical pinch-off behavior, as well as the formation of the consequent satellite droplets, by varying order parameters of liquid crystal bulk and interfacial anchoring energy constant. Qualitative agreements with experimental results are observed.
Author: Xiaofeng Yang, University of South Carolina, USA

Efficient spectral-Galerkin methods for systems of coupled elliptic equations with applications in phase-field modeling

While spectral methods for single elliptic equations have been well established in many situations, there are few for systems of coupled elliptic equations. It is hard in general due to the strong coupling among equations and the high dimensionality in real applications. Another interesting question is how to design an algorithm with a complexity that depends linearly on the number of equations. I will talk about how we solve above issues with the new spectral-Galerkin method we developed for systems of coupled elliptic equations. I will show applications in isotropic and anisotropic Cahn-Hilliard equations, gradient flow equations from functionalized polymers, and phase-field-crystal equations.

Author: Feng Chen, Purdue University, USA

3-D Numerical Simulations of Biofilm Growth and Interaction with Flows

We study the biofilm-flow interaction using the phase field model. We provide and analyse a model for biofilms based on the concept of extracellular polymeric substances as a polymer solution. The bacteria are embeded in the network and produce the polymer. We also extended the bi-component model to a tri-component model, where the EPS network, bacteria and effective solvent consisting of the solvent, nutrient, drugs etc. are modeled explicitly. The growth of the biofilm and the solvent-biofilm interaction are simulated in the viscous regime, in which the molecular relaxation is negligible in the corresponding time scale. The interaction between the biofilm and the solvent flow field is simulated in a shear cell in the regime of weak flow. These models along with the simulation tools developed provides a new paradigm for studying biofilm-flow interaction and other important biological interactions in microorganisms.

Author: Chen Chen, University of South Carolina, USA

Modeling of Biocide Action against Biofilm

We consider the mathematical model of dynamic antimicrobial action against bacterial biofilm. A one-fluid two-component model is used in which the biofilm consisting of live and dead bacteria is modeled as one fluid component, while the solvent containing biocide is modeled as the other, and each component is represented by its volume fraction. The whole system is assumed to be an incompressible fluid and the velocity is governed by Navier-Stokes equation. Biocide kills the live bacteria and its transport is governed by an advection-reaction-diffusion equation. Certain biocide also weakens the mechanical cohesiveness of the biofilm and results biofilm removal under the shear stress of external flow. Spatial and temporal patterns of antimicrobial action of three different biocides are considered and numerical simulation results by finite difference method are presented.

Author: T. Zhang, Montana State University, USA

MS7: Asymptotic Dynamics of Dissipative Evolution Equations - Part I of III

Poisson-Nernst-Planck type models for ionic flows and ion size effect on I-V relations

We discuss recent progresses on studies of Poisson-Nernst-Planck type models including ionic interactions for ionic flows. The model can be viewed as a singularly perturbed integro-differential system and our analysis is a combination of geometric singular perturbation theory and functional analysis. In particular, an approximation of the I-V (current-voltage) relation is derived from which a number of nontrivial consequences can be drawn on ion size effect to I-V relations.

Author: Weishi Liu, University of Kansas, USA

A Reaction-Diffusion Problem with Nonlocal Reaction

When incorporating a bio-feedback into an energy balance climate model, one obtains a nonautonomous functional reaction-diffusion problem with a setvalued reaction term which depends on a nonlocal Volterra operator. A global existence result for nonnegative solutions as well as the

existence of a trajectory attractor are discussed.
Author: Georg Hetzer, Auburn University, USA

Traveling Wave Solutions in Partially Degenerate Cooperative Reaction-Diffusion Systems
We discuss the existence of traveling wave solutions for partially degenerate cooperative reaction-diffusion systems that can have three or more equilibria. We show via integral systems that there exist traveling wave solutions in a partially degenerate reaction-diffusion system with speeds above two well-defined extended real numbers. We prove that the two numbers are the same and may be characterized as the spreading speed as well as the slowest speed of a class of traveling wave solutions provided that the linear determinacy conditions are satisfied. We demonstrate our theoretical results by examining a partially degenerate Lotka-Voltarra competition model with advection terms.
Author: Bingtuan Li, University of Louisville, USA

A spectral condition for strong stability of non-autonomous linear equation
In this talk I will speak of an approach to strong stability of non-autonomous linear equations via evolution semigroup method in minimal function spaces. In minimal function spaces the spectrum of the evolution semigroup associated with a class of non-autonomous equations will be analyzed to show that some well known results for strong stability for semigroups can be extended to nonautonomous linear equations. The obtained results can be stated in terms of Perron conditions.
Author: M.V. Nguyen, University of West Georgia, USA

MS8 Numerical Methods for Incompressible Flow Problems - Part I of II

A Finite Element Discretization of the Streamfunction-Vorticity Formulation of the Quasi-Geostrophic Equations
In this talk, we will discuss the finite element discretization of the Quasi-Geostrophic equations in the streamfuction-vorticity formulation, which is widely used in the geophysics community to describe the large scale motion of the ocean currents. Rigorous numerical analysis for the finite element discretization is developed and the method is tested numerically on an ocean basin flow driven by a symmetric double-gyre wind force, which displays a four-gyre mean circulation pattern.
Authors: Zhu Wang, Virginia Tech, USA

Two kinds of 2nd order IMEX methods for Stokes-Darcy system
This is a joint work with Wenbin Chen, Max Gunzburger and Xiaoming Wang. We study two kinds of 2nd order Implicit-Explicit (IMEX) methods for Stokes-Darcy system. One is the Backward Differentiation Formula (BDF) and the other is the Adams-Moulton-Bashforth (AMB). We prove unconditional and long-time stability for both schemes. Error estimates are discussed and numerical examples are implemented to present the efficiency of the two schemes.
Authors: Dong Sun, Florida State University, USA.

An adaptive approach to PDE-constrained optimization for random data identification problems
In this talk we will present a scalable mechanism for optimal identification of statistical moments or even the whole probability distribution of input random data, given the probability distribution of some response of a system of PDEs. This novel technique integrates an adjoint-based deterministic algorithm with the sparse grid stochastic collocation FEM. Our rigorously derived error estimates and several numerical examples, will be described and used to compare the efficiency of the method with several other techniques.
Author: Clayton Webster, Oakridge National Laboratory, USA

Covolume-Upwind Finite Volume Approximations for Linear Elliptic Partial Differential Equations

In this talk, we discuss covolume-upwind finite volume methods on rectangular meshes for solving linear elliptic partial differential equations with mixed boundary conditions. To avoid non-physical numerical oscillations for convection-dominated problems, nonstandard control volumes (covolumes) are generated based on local Peclet's numbers and the upwind principle for finite volume approximations. Two types of discretization schemes with mass lumping are developed with use of bilinear or biquadratic basis functions as the trial space respectively. Some stability analyses of the schemes are presented for the model problem with constant coefficients. Various examples are also carried out to numerically demonstrate stability and optimal convergence of the proposed methods.
Authors: Lili Ju, University of South Carolina, USA

MS9 Computational Tools and Quantitative Methods for High Dimensional Data Analysis - Part I

Model-Based Methods for Analyzing NGS Data

The next generation sequencing (NGS) technologies have been rapidly adopted in an array of diverse applications. Although extremely promising, the massive amount of data generated from NGS, substantial biases and correlation pose daunting challenges for data analysis. By treating observed data as random samples from probability distributions, model-based methods can accommodate uncertainties explicitly and also automatically leads to rigorous statistical inference. Inspired by the success of model-based methods in the analysis of other high throughput genomics data such as microarray, we strived to develop novel model-based methods to analyze the complicated data generated from the new NGS-based experiments, aiming to help biologists to extract new biological insights from massive NGS data.
Authors: Peter Meng Zhao, Emory University, USA; Steve Zhaohui Qin Emory University, Atlanta, USA.

Unsupervised fMRI Data analysis using graph-based visualizations of self-organizing maps

The self-organizing map (SOM) is an artificial neural network model that has been successfully used for unsupervised functional magnetic resonance imaging (fMRI) analysis. However, a post-processing scheme is necessary to delineate data clusters via SOM output nodes. In this work, we used novel graph-based visualizations of node connectivity based upon distribution of data and correlation between the nodes. This helped in advanced visualization enabling the separation of brain functional regions with small timing differences.
Author: Santosh Katwal, Vanderbilt University, USA.

Multi-resolution Analysis Method for IMS Data Biomarker Selection and Classification

Imaging Mass Spectrometry (IMS) has shown great potential and is very promising in proteomics. However, challenges remain in data processing. In this talk, we present some recent progress on IMS data biomarker selection and classification by using multi-resolution analysis methods. We apply the idea of wavelet pyramid method used in image matching to do biomarker selection from wavelet coefficients space and combine naive Bayes classifier to do classification on wavelet coefficient space. The analysis results showed that the wavelet method works efficiently and effectively for dealing with hyper-spectral data such as IMS.
Authors: Lu Xiong, Middle Tennessee State University, USA; Don Hong, Middle Tennessee State University, USA

Deriving protein inventories from tandem mass spectra

Modern mass spectrometry generates tens of thousands of tandem mass spectra in an hour, with each scan potentially representing a different peptide sequence. Proteome informatics seeks to match each spectrum to a peptide sequence, discern which spectra have been successfully identified,

and assemble a protein list from the set of confident peptides. This talk will examine the chief approaches used for each of these steps in typical shotgun proteomics workflows.'
Author: Dave Tabb, Vanderbilt University, USA.

CS1: Contributed Session I

Pseudo-twins and isomorphic subgraphs

We show that a number of graph invariants are, even combined, insufficient to distinguish between nonisomorphic trees or general graphs. Among these are: the set of eigenvalues (equivalently, the characteristic polynomial), the number of independent sets of all sizes or the number of connected subgraphs of all sizes. We therefore extend the classical theorem of Schwenk that almost every tree has a cospectral mate, and we provide an answer to a question of Jamison on average subtree orders of trees. The simple construction that we apply for this purpose is based on finding graphs with two distinguished vertices (called pseudo-twins) that do not belong to the same orbit but whose removal yields isomorphic graphs. This is joint work with Stephan Wagner.
Authors: Hua Wang and Stephan Wagner, Gerogia Southern University, USA

Opial type Diamond-Alpha Dynamic Inequalities and Applications

In view of the recently developed theory of diamond-alpha dynamic derivatives and integrals, which are convex combinations of the corresponding delta and nabla concepts, generalized Opial type inequalities are given along with applications to boundary value problems.
Author: Billur Kaymakcalan, Cankaya University, Turkey

Some Computational Challenges in Analyzing Global Dynamics of Certain Nonlinear Discrete Dynamical Systems

We present some computational challenges involved in analyzing global behavior of solutions to certain classes of nonlinear discrete dynamical systems which have applications in mathematical biology and ecology. We also suggest some innovative geometric and computer-based approaches to overcome these challenges.
Author: Sukanya Basu, Grand Valley State University, USA

Infeasible Full-Newton-Step Interior-Point Method for Linear Complementarity Problems

In this talk, we present an infeasible Full-Newton-Step Interior-Point Method for Linear Complementarity Problems. The advantage of the method, in addition to starting from an infeasible starting point, is that it uses full Newton-steps, thus avoiding the calculation of the step size at each iteration. However, by suitable choice of parameters iterates are forced to stay in the neighborhood of the central path, thus, still guaranteeing the global convergence of the method. The number of iterations necessary to find epsilon-approximate solution of the problem matches the best known iteration bounds for these types of methods.
Author: Goran Lesaja, Georgia Southern University, USA

IP2 Plenary Talk: What Do Mosquitofish, Shrimp and Proliferating CD4+ T-Cells Have in Common?

The short answer is uncertainty in dynamics and population data. In this talk, we discuss some recent projects involving probability, statistics and, of course, mathematics. We will focus on a recent (2005-2008) joint project with a company, Advanced BioNutrition Corporation (ABN) of Columbia, MD, on development of models for shrimp populations as a scaffold in a rapid vaccine production system. We will explain how some basic questions in the science of this project have led to longer term basic research questions in modeling and computation of variability and uncertainty in research efforts for our team members. We hope to do this in a way in which no specific facts from probability and statistics are required to understand the presentation.
Author: H.T. Banks, Center for Research in Scientific Computation and Department of Mathematics

North Carolina State University, USA

MS10 Recent Advances in Computational and Stochastic Methods in Fluid Dynamics with Control and Estimations - Part II of II

A Bayesian approach to data assimilation in hemodynamics

In this talk we discuss a Bayesian data assimilation technique for hemodynamics. Our method is formulated as a control problem where a misfit between data and velocity is minimized subject to the Navier-Stokes equations. The resulting probability density function of the velocity is used to derive its statistical estimators and confidence regions. We present numerical results on 2D and 3D approximations of blood vessels, we compare statistical and deterministic estimators and we draw velocity confidence regions.
Author: Marta D'Elia, Florida State University, USA

Martingale Solutions for Stochastic Navier-Stokes Equations with to-Levy Noise

In this talk, we discuss the solvability of martingale problem for the stochastic Navier-Stokes equations with Ito-Levy noise under appropriate conditions in bounded and unbounded domains in R^d; d = 2; 3. The tightness criteria for the laws of a sequence of semi-martingales is obtained from a theorem of Rebolledo as formulated by Metivier for the Lusin space valued processes. The existence of martingale solutions (in the sense of Stroock and Varadhan) relies on a Minty stochastic lemma which is essentially obtained from a local monotonicity of the drift term.
Authors: Sakthivel Kumarasamy, Naval Postgraduate School, USA; S.S. Sritharan, Naval Postgraduate School, USA

Numerical solution of ice-sheets dynamics

Ice-sheets dynamics play a significant role in Climatology. Several models, characterized by different complexity and accuracy, have been proposed for describing ice-sheets dynamics. In this work we present a parallel finite element implementations of some of them. We compare the results obtained using these different models on Greenland and Antarctica ice-sheets. Also, we explore different strategies for the solution of the resulting non linear system, with particular care to the scalability of the solution.
Author: Mauro Perego, Florida State University, USA

Manipulation of Micro-Particles Suspended in Fluids Using Vibrating Cilia

Vibrating cilia allow certain aquatic micro-organisms to establish streaming flows that assist in the collection of nearby food particles. Artificial cilia have been used to establish similar flows for applications like the polishing of brittle surfaces using abrasive particles suspended in water. This talk will describe efforts to model problems like these analytically and computationally, advancing from the idealized extreme of Stokes flow to that of finite Reynolds–number flow.
Author: Scott David Kelly, University of North Carolina at Charlotte, USA

MS11 Discontinuous Galerkin Methods - Part I of II

HDG Methods for the Vorticity-Velocity-Pressure Formulation of the Stokes Problem

In this talk we discuss a hybridizable discontinuous Galerkin (HDG) method for solving the vorticity-velocity-pressure formulation of the three-dimensional Stokes equations of incompressible fluid flow. The idea of the a priori error analysis consists in estimating a projection of the errors that is tailored to the very structure of the numerical traces of the method. We prove that, when all the unknowns use polynomials of degree k greater than or equal to 0, the L^2- norm of the errors in the approximate vorticity and pressure converge to zero with order $k + 1/2$ whereas

the error in the approximate velocity converges with order $k+1$. This is joint work with Bernardo Cockburn from University of Minnesota.
Author: Jintao Cui, University of Minnesota, USA

Analysis of HDG methods for the Oseen and Navier-Stokes equations
In this work, we propose a hybridizable discontinuous Galerkin (HDG) method to numerically solve the Oseen equations. First, we prove that if same polynomial degree approximations are used for the velocity, its gradient and the pressure, we obtain optimal convergence for all the variables. With a special projection and postprocessing, we further obtain a divergence-conforming, divergence-free velocity which converges with an additional order. We provide a numerical example to verify the theoretical convergence rates. The method then can be extended to the Navier-Stokes case by using a fixed point iteration. This is joint work with Bernardo Cockburn, Ngoc Cuong Nguyen and Jaime Peraire.
Author: Aycil Cesmelioglu, University of Minnesota, USA

Penalty-Free Discontinuous Galerkin Methods for the Navier-Stokes Equations
Formulation and analysis of first order penalty-free discontinuous Galerkin (DG) method for steady incompressible Navier-Stokes equations are given. Removing the penalty term in standard symmetric and non-symmetric DG formulation results in an unstable scheme. To overcome instability, the velocity space is enriched with local quadratic bubbles. The proof of the analysis is based on a fixed point theorem.
Author: Shirin Sardar, Rice University, USA

Convergence Analysis of an Adaptive Interior Penalty Discontinuous Galerkin Method for the Helmholtz Equation
We consider the numerical solution of the 2D Helmholtz equation by an adaptive Interior Penalty Discontinuous Galerkin (IPDG) method based on adaptively refined simplicial triangulations of the computational domain. The a posteriori error analysis involves a residual type error estimator consisting of element and edge residuals and a consistency error which, however, can be controlled by the estimator. The refinement is taken care of by the standard bulk criterion (Doerfler marking) known from the convergence analysis of adaptive finite element methods for linear second order elliptic PDEs. The main result is a contraction property for a weighted sum of the energy norm of the error and the estimator which yields convergence of the adaptive IPDG approach. Numerical results are given that illustrate the quasi-optimality of the method.
Author: Natasha Sharma, University of Houston, USA

MS12: Modeling and Dynamics of Networks and Cancer Growth and Invasion

Perturbation Control in Genetic Regulatory Networks
Current research in cancer biology indicates that global, systemic molecular interactions are pivotal in understanding cellular dynamics, and in designing intervention strategies to combat genetic diseases. In particular, most genetic ailments, such as cancer, are not caused by a single gene, but rather by the interaction of multiple genes. Global, holistic approaches to the study of biological systems reveal the dynamic nature of cellular networks, which provide an important framework for drug discovery and design. The massive amounts of information that omics (e.g., genomics, proteomics, metabolomics) high-throughput sequencing technology generate marked a great leap forward in computational methods for analyzing and interpreting biological data. However, it remains a major challenge to design optimal intervention strategies in order to affect the time evolution of gene activity in a desirable manner. One of the main aims of modern biological research is focused on intervening in biological cell dynamics in order to alter the gene regulatory network and avoid undesirable cellular states; e.g., metastasis. Biological evidence suggests that steady-states

of genetic regulatory networks are related to different phenotypes, or cellular functional states, such as tumorigenesis. The control objective is then to reduce the probability that the network will end up in an undesirable steady-state. We propose to linearly perturb the network in order to force it away from an undesirable steady-state distribution and into a desirable one. We show that there are infinitely many feasible perturbations, which can be considered as plausible intervention strategies. We cast the optimal perturbation control as a convex optimization problem, which can be solved using efficient convex optimization solvers. We further investigate the robustness of the optimal perturbation control to errors in the data, and demonstrate that the proposed optimal perturbation control is robust to data and inference errors in the original network. Finally, we apply the proposed optimal perturbation control method to the Human melanoma gene regulatory network in order to force the network from an initial steady-state distribution associated with melanoma and into a desirable steady-state distribution corresponding to a benign cell.
Author: Nidhal Bouynaya, University of Arkansas, USA

Calibration of growth models for metastasis to the lung
The evolution of thyroidal lung nodules may be difficult to evaluate. Furthermore, when unwell patients are concerned, physicians try to minimize the use of invasive techniques, restricting treatment (by radiofrequency ablation) to nodules that may become malignant. Thus, an accurate prognosis of each nodule is critical. We propose a numerical method of predicting the actual tumour growth for a specific patient. The prediction is given by a solution of a PDEs system whose parameters are determined by solving an inverse problem. The data for the inverse problem comes from a series of CT scans.
Author: Thierry Collin, University of Bordeaux, France

Global asymptotic Stability of a Model of Biological networks
Global asymptotic stability (GAS) is a key feature of the dynamical behavior of biological networks, as it excludes periodic orbits and multistability by extending the basin of attraction of a stable point to the entire space. In the context of general cellular networks, GAS is important as it implies that the concentration of a molecule always returns to the same steady state regardless of any perturbation (short of cell death). We construct a suitable Lyapunov function for a system of ODEs, related to the Lotka-Voltera model, which models molecular networks and derive a sufficient condition for GAS. We will discuss a sufficient condition for global stability of an unique interior equilibrium . We apply the theorem to derive GAS in important classes of molecular networks, including negative feedback loop (NFL) systems of arbitrary size. We discuss biological relevance and provide numerical examples.
Authors: Hassan M Fathallah-Shaykh, Abraham Freiji,University of Alabama in Birmingham, USA.

Modeling of the response to a treatment for metastasis to the liver of a GIST
We study the evolution of liver metastasis of a GIST (Gastro Intestinal Stromal Tumor). Usually, when the metastasis appears, the patient received imatinib (a tyrosine kinase inhibitor). Usually, the patient has a good response to this treatment, but at some time, it escapes. The oncologist has then to change the treatment and switch to sunitinib that is an anti-angiogenesis drug. Usually the patient has also a good response to this treatment, before it escapes again. We propose a PDE model to explain this behavior and we show some numerical results and comparison with some clinical cases.
Author: T. Collin, University of Bordeaux, France

Theory and Experimental Results on 2-element Negative Loops
Negative loops, present in almost all biological networks, play a central role in generating molecular oscillations. The ribosomal RPS3 protein/mRNA is example of a 2-element biological loop as the RPS3-protein represses its own translation. We study the analytical theory of the stability of two-dimensional negative loops modeled by a new nonlinear system of ordinary differential equations.

We also build the RPS3 2-element negative loop inside a living cell and monitor its dynamics by time-lapse microscopy. We will review theoretical predictions and biological validation.
Authors: Abraham Freiji and Hassan Fathallah-Shaykh, University of Alabama in Birmingham, USA.

MS13 Modeling Complex Biological Systems: Theoretical and Computational Studies - Part I of III

Modeling the Transmission Dynamics of Antibiotic Resistant Bacteria in Hospitals

The development of drug-resistant strains of bacteria is an increasing threat to society, especially in hospital settings. Many antibiotics that were formerly effective in combating bacterial infections in hospital patients are no longer effective due to the evolution of resistant strains. The evolution of these resistant strains compromises medical care worldwide. In this talk, we will briefly review some recent studies on modeling the transmission dynamics of antibiotic resistant bacteria in hospitals. We will also introduce a compartmental model to describe the transmission characteristics of meticillin-resistant Staphylococcus aureus (MRSA) in the emergency ward and respiratory intensive care unit in Beijing Tongren Hospital, China.
Author: S. Ruan, University of Miami, USA

Spatiotemporal Mutualistic Model of Mistletoes and Birds

A mathematical model which incorporates the spatial dispersal and interaction dynamics of mistletoes and birds is derived and studied to gain insights of the spatial heterogeneity in abundance of mistletoes. Fickian diffusion and chemotaxis are used to model the random movement of birds and the aggregation of birds due to the attraction of mistletoes respectively. The spread of mistletoes by birds is expressed by a convolution integral with a dispersal kernel. Two different types of kernel functions are used to study the model, one is Dirac delta function which reflects one extreme case that the spread behavior is local, and the other one is a general non-negative symmetric function which describes the nonlocal spread of mistletoes. When the kernel function is taken as the Dirac delta function, the threshold condition for the existence of mistletoes is given and explored in term of parameters. For the general non-negative symmetric kernel case, we prove the existence and stability of non-constant equilibrium solutions. Numerical simulations are conducted by taking specific forms of kernel functions. Our study shows that the spatial heterogeneous patterns of the mistletoes are related to the specific dispersal pattern of the birds which carry mistletoe seeds. This is a joint work with Rongsong Liu, Chencheng Wang and Carlos Martinez del Rio of University of Wyoming.
Author: J. Shi, College of William and Mary, USA

Effects of Fluid Dynamics on Bacterial Disinfection

Bacterial biofilms are widely acknowledged to be sources of recalcitrant infections and colonization in a variety of medical, environmental and industrial settings. This recalcitrance is evidenced by recurrence of the infection, even after extremely long application of biocides or antibiotics. Explanations for this tolerance include physical protection of the bacteria by the surrounding extracellular matrix, physiological protection arising from nutrient gradients formed by the spatial distribution of the bacteria within the biofilm and the existence of specialized phenotypes of bacteria that forgo reproduction in order to evade the antimicrobial agent. This talk will focus on the analysis of recent models that incorporate all of these tolerance mechanisms into a model of biofilm dynamics. In particular, we will focus on the act of the external flow environment on the disinfection process. The contrast between dynamics within free channels and partially blocked channels indicates that the spatial environment plays a much stronger role than has been previously thought.
Author: N. Cogan, Florida State University, USA

Fast simulations of pseudo-time coupled nonlinear biomolecular solvation systems
Recently, we have introduced a pseudo-time coupled PDE model for biomolecular solvation analysis. A smooth solvent-solute interface is considered to characterize the dielectric boundary between macromolecules and the surrounding aqueous environment. A nonlinear Poisson-Boltzmann (NPB) equation is used for representing the nonlinear electrostatic effect. To speed up, we propose to solve the time-transient NPB equation by using operator splitting based alternating direction implicit (ADI) schemes. With an analytical treatment of nonlinear term, the proposed ADI schemes are found to be unconditionally stable for solving NPB equation. In solving coupled PDEs for chemical compounds and proteins, the proposed numerical schemes are very efficient, because large time increments are allowed.
Authors: Shan Zhao, University of Alabama in Tuscaloosa, USA

MS14 Computational Tools and Quantitative Methods for High Dimensional Data Analysis - Part II of III

Imaging-Driven Mathematical Modeling of Tumor Growth and Treatment Response
While elaborate mathematical models of tumor growth may exist, they are not of the form that can be applied to clinical data. We will argue that clinically relevant mathematical modeling of tumor growth can be achieved by incorporation of non-invasive, quantitative imaging. We will present three examples: 1) incorporating MRI data into the logistic equation, 2) MRI based simulations of a reaction-diffusion equation incorporating mechanical resistance, and 3) PETMRI based simulations of an angiogenesis-proliferation model.
Authors: Thomas Yankeelov, Vanderbilt University, USA; Nkiruka Atuegwu, David Hormuth and Jared Weis, Institute of Imaging Science, Vanderbilt University, USA

Computational Imaging Approaches for Quality Assurance in Diffusion Tensor Imaging
Diffusion Tensor Imaging (DTI) is an invaluable MRI method that probes cytoarchitecture on the micrometer level. Estimated contrasts from DTI experiments are known to contain bias that is sensitive to noise and acquisition method. Differing inter-method bias obscures comparison of data from different DTI protocols and prevents collaborative pooling of data. We will discuss statistical methods to estimate distributional properties for metrics derived from DTI acquisitions and present computational approaches to improve inter-method compatibility.
Authors: Carolyn Lauzon, Vanderbilt University, USA; Bennett A Landman, Vanderbilt University, USA.

A hierarchical group ICA model for estimating temporal and spatial patterns of brain networks
I propose a new hierarchical group independent component analysis (ICA) model for characterizing neural networks in multi-subject brain imaging studies. Unlike existing group ICA models which analyze multi-subject data in a similar manner as in the single-subject analysis, the proposed new method models subject-specific effects through a hierarchical ICA model, providing more accurate estimation of brain networks on both the population and subject level. An EM algorithm is developed for model estimation.
Author: Ying Guo, Emory University, USA

Visualizing Global Cluster-Compressed Multivariable and Multi-altitude Atmospheric Data
This talk addresses the challenge of visualizing global cluster-compressed atmospheric data derived from the Atmospheric Infrared Sounder (AIRS) using for four different software tools. NASA's Level 3 cluster-compress products have varying numbers of 35 variate summary vectors (mostly temperature, water vapor and cloud fraction at different altitudes) for different 5 degree grid cells of the earth. Of the three dynamic graphics tools tried,only one scaled to the globe. Two are potential useful for local summaries. The fourth approach produced overviews using R to cluster

earth grid cells using the earth mover's distance yielded different suggestive clusters over time. Progress has been made in automated color selection for the clusters.
Authors: Daniel B. Carr, George Mason University, USA; John Ashley, NVidia, USA.

Feature selection by support vector machines
In this talk, I will present a pseudo aggregate method for feature selection using support vector machines. In this method, we train a large number of models. For each model, support vector machine recursive feature elimination is used to rank and select important features. Then a frequency based re-ranking is used to integrate all the obtained models to stabilize the feature ranking. This method is shown to be effective in stylometry analysis.
Author: Q. Wu, Middle Tennessee State University, USA.

MS15 Advances in Inverse Problems - Part I of II

An image method for a sphere in an acoustic wave-guide
The scattering of acoustic waves by a sphere in a shallow ocean wave guide is investigated. Expressions for the scattered waves are given. Numerical values for a quantity called the far-field form function for various depth are presented in graphical forms. Also we investigate the unknown body problem in a wave-guide. The Rayleigh conjecture states that every point on an illuminated body radiates sound from that point as if the point lies on its tangent sphere. This conjecture is the cornerstone of the intersecting canonical body approximation ICBA for solving the unknown body inverse problem. Therefore, the use of the ICBA requires that an analytical solution be known exterior to the sphere in the wave-guide, which leads us to analytically compute the exterior solution for a sphere between two parallel plates. A least-squares matching of theoretical acoustic fields against the measured, scattered field permits a reconstruction of the unknown object.
Authors: Robert Gilbert and Doo-Sung Lee, University of Delaware, USA.

Active manipulation of fields and applications
The idea of active manipulation of fields initially originated in the works of Guevara Vasquez, Milton and Onofrei for the problem of acoustic cloaking. In this talk we will show that the cloaking problem studied before is a particular case of a more general integral equation and we will study this new general problem. We will discuss the existence of solutions, stability of the associated minimal energy solution and the possibility to control the near field of the minimum energy solution.
Author: Daniel Onofrei, University of Houston, USA.

Optimal Source in Diffuse Optical Tomography
In this talk, an extension of the distinguish-ability criteria of Isaacson and Knowles to optimal source in Diffuse Optical Tomography will be discussed. The influence of the inner products of the function spaces on the resulting optimal source will be demonstrated using simulations.
Author: Taufiquar Khan, Clemson University, USA.

Inverse scattering for a left-definite problem
The Camassa-Holm equation is a nonlinear evolution equation describing certain wave phenomena. The Cauchy problem for this PDE can be tackled by solving a scattering and an inverse scattering problem for the linear Sturm-Liouville equation $-y'' + y = \lambda wy$ where λ is a complex parameter and w a function connected to the Camassa-Holm equation. Particularly interesting, since it is related to wave breaking, is the case where w changes sign. This prevents setting up the problem in $L^2(w)$. Instead one can use the left-hand side of the equation to define a positive-definite inner product forming the basis for a spectral and scattering theory. This is joint work with Christer Bennewitz (Lund) and Malcolm Brown (Cardiff).
Authors: Rudi Weikard, University of Alabama in Birmingham, USA.

MS16 Applied and Computational Harmonic Analysis - Part II of III

Lightening the Load: Low Complexity Discrete Energy Problems with Varying Weights

We consider asymptotic (as $N \to \infty$) geometrical properties of N-point configurations $\{x_i\}_{i=1}^N$ on a $d-$rectifiable set A that minimize a weighted Riesz s-energy functional of the form $\sum_{i\neq j} w_N(x_i, x_j)/|x_i - x_j|^s$, for a given 'weight' function w_N on $A \times A$ and a parameter $s > 0$. In previous work, we described the asymptotic distribution for such problems when the weight w was a 'CPD' weight not depending on N. We extend these results to the case of N-dependent weights. In particular, we consider weights that lead to lower complexity energy calculations.
Author: Douglas Hardin, Vanderbilt University, USA.

Geometric Optimization of Finite Unit-Norm Tight Frames

We present an algorithm and convergence theory for an approximate geometric gradient descent procedure over the space of finite unit-norm tight frames. This algorithm is powered by fast minimization of the frame potential and explicit characterizations of the tangent spaces on the space of finite unit-norm tight frames. We apply this procedure to perform numerical searches for approximately Grassmannian frames.
Author: Nathaniel Strawn, Duke University, USA.

GPU Accelerated Greedy Algorithms for Compressed Sensing

Greedy algorithms for compressed sensing are efficient, suboptimal algorithms to solve the combinatorial optimization problem $\min |x|_0$ subject to $y = Ax$, where $|\cdot|_0$ counts the nonzero entries and A is $n \times N$ with $n < N$. Exploiting the computational power of graphics processing units (GPU) permits testing on problems orders of magnitude larger than experiments in the literature. This massive computational acceleration and increase in testing capability provide numerous insights to the greedy algorithms including when each algorithm boasts the best performance.
Author: Jeffrey Blanchard, Grinnell College, USA.

Consistent signal reconstruction and the geometry of some random polytopes

Consistent reconstruction is a linear programming technique for reconstructing a signal $x \in R^d$ from a set of noisy or quantized linear measurements. In the setting of random frames combined with noisy measurements, we prove new mean squared error (MSE) bounds for consistent reconstruction. In particular, we prove that the MSE for consistent reconstruction is of the optimal order $1/N^2$ where N is the number of measurements, and we prove bounds on the associated dimension dependent constant. For comparison, in the important case of unit-norm tight frames with linear reconstruction (instead of consistent reconstruction) the mean squared error only satisfies a weaker bound of order $1/N$. Our results require a mathematical analysis of random polytopes generated by affine hyperplanes and of associated coverage processes on the sphere. This is joint work with Alex Powell.
Author: J. Tyler Whitehouse, Vanderbilt University, USA.

MS17: Generalized Finite Element Methods for PDEs

Mapping Techniques for Isogeometric Analysis of Elliptic Boundary Value Problems Containing Singularities

We introduce mapping techniques into isogeometric analysis to deal with point singularities (cracks and jump boundary data) that arise in elliptic boundary value problems. The proposed method makes it possible to independently control the radial and angular direction of the function to be approximated as far as the point singularities are concerned. We prove error estimates in Sobolev norms and demonstrate that the proposed mapping technique is highly effective for isogeometric analysis of elliptic boundary value problems with singularities.
Author: Hyunju Kim, University of North Carolina at Charlotte, USA.

A Generalized Finite Element Method for the Displacement Obstacle Problem of Clamped Kirchoff Plates
The displacement obstacle problem for clamped Kirchoff plates is an example of a fourth order variational inequality. We can approximate the solution to this problem using a generalized finite element method, and solve the resulting system using an active set algorithm. In this talk, numerical results from the proposed method will be shown for various problems on convex and nonconvex domains.
Authors: Chris Davis, Li-Yeng Sung and Susanne Brenner, Louisiana State University, USA.

Patchwise Reproducing Polynomial Particle Method for Three-Dimensional Elliptic Boundary Value Problems with Singularities
Meshless methods have several advantages over the conventional finite element method. However, they have some difficulties such as large matrix condi- tion numbers, complicated (or non smooth) partition of unity (PU) functions, ineffectiveness in handling essential boundary conditions, and so on. In order to alleviate these diffculties, Oh et al. introduced Reproducing Polynomial Particle Method (RPPM) with use of the PU functions with at-top. The PU functions with at-top usually lead to the small matrix condition number. On the other hand, meshless shape functions do not satisfy the Kronecker delta property in general. Moreover, the supports of PU functions are overlapping one another. Therefore, imposing essential boundary conditions in meshless methods are more diffcult than that of the conventional finite elements. Oh et. al introduced an almost everywhere partition of unity to effectively handle essential boundary conditions for two dimensional elliptic problems. In this paper, we extend this approach to the three dimensional cases to deal with 3-dim domain singularities. We prove the convergence of the proposed method.
Author: Hae-Soo Oh, University of North Carolina at Charlotte, USA

Higher Order Stable Generalized Finite Element Method
The Generalized Finite Element Method (GFEM) is an extension of the standard Finite Element Method (FEM), where the standard finite element approximating subspace is augmented with enrichment functions that locally mimic the unknown solution of the underlying PDE. The GFEM has been successfully applied to problems with singularities, interfaces, cracks, and other features. However, the condition number of the stiffness matrix, associated with GFEM, could be much larger than that of the FEM, and it could be difficult to compute the the solution of the underlying linear system. To address this issue, the enrichment functions in the GFEM were modified and the approach was referred to as the Stable GFEM (SGFEM). It was proved that, under certain conditions, that the condition number of the stiffness matrix, associated with SGFEM, is not worse than that of the FEM. Moreover, SGFEM yields the optimal convergence rate, name $O(h)$, where h is the discretization parameter. However, the conditions required in the existing theory of SGFEM may not hold, when the SGFEM is extended, based on the existing framework, to obtain higher order approximation. In this talk, we will highlight these difficulties. Moreover, we will suggest further modifications of the enrichment functions that overcome these diffculties. These modifcations are element based and the extra computations could be performed element-wise. The SGFEM, based on these modified enrichment functions, yield higher order convergence and the order of the condition number of SGFEM is not worse than that of FEM.
Author: Uday Banerjee, Syracuse University, USA

CS2: Contributed Session II

The Discrete Agglomeration Model: Equivalent Problems
Agglomeration of particles in a fluid environment is an integral part of many industrial processes and has been the subject of scientific investigation. One model of the fundamental mathematical problem of determining the number of particles of each particle-size as a function of time for a system of particles that may agglutinate during two particle collisions uses the coagulation or

Smoluchowskis equation. With initial conditions, it is called the Discrete Agglomeration Model. Several problems have been associated with this model allowing progress to proceed separately. To facilitate this progress, in this paper we develop equivalent problems.
Author: James Moseley, West Virginia University, USA

Matched Filter for a Chaotic Differential Equation

A chaotic differential equation is shown to admit a simple matched filter for detecting symbolic information. The low-dimensional oscillator offers an exact analytic solution as the linear convolution of a basis pulse and a discrete information sequence. The matched filter output provides optimal symbol detection in noise, and the bit-error rate for detecting symbols is derived. Experimental results using electronic oscillators confirm the effectiveness of the matched filter for detecting symbols. This system has potential application in Hayes-type chaos communications, where a message is encoded in a symbolic dynamics via small perturbations. The discovery of a matched filter finally provides a receiver to complement the elegant encoding in such systems.
Author: Ned Corron, U.S. Army RDECOM, USA

Non-autonomous Boolean chaos in a driven ring oscillator

A non-autonomous architecture for generating Boolean chaos is introduced. Specifically, the system is a ring oscillator driven by a periodic external signal. Experimentally observed dynamics are reproduced in numerical solutions of a simple deterministic model. Further experimental observations confirm deterministic chaos is the source of observed irregular oscillations. First, the scale dependent Lyapunov exponent determined from experimental time series displays a plateau characteristic of deterministic chaos. Second, synchronization between coupled oscillators is demonstrated under a variety of coupling schemes.
Author: Jonathan Blakely, U. S. Army Aviation and Missile Res., Dev., and Eng. Center, USA

3D Structured Adaptive Mesh Refinement and Multilevel Preconditioning for Non-Equilibrium Radiation Diffusion

This talk will describe a highly efficient solution method for the coupled non- linear time dependent non-equilibrium radiation diffusion equations combin- ing fully implicit time integration schemes with 3D adaptive mesh refinement (AMR). This coupled system of nonlinear equations exhibits multiple temporal and spatial scales rendering it a stiff coupled system to solve. In the literature, previous work has described solution methods for the non-equilibrium radiation diffusion equations that combine implicit time integration with preconditioned Jacobian free Newton-Krylov (JFNK) methods for the nonlinear solves at each timestep on uniform as well as unstructured grids. Typically a multigrid pre-conditioner was used for the Krylov methods. In this paper, we advance the state of the art by combining the efficiency obtained with respect to time integration in the previous methods with efficiency in space by introducing 3D block structured adaptive mesh refinement and preconditioning using the multilevel Fast Adaptive Composite Grid (FAC) method. In addition, progress permitting we will compare the performance of FAC with asynchronous variants such as AFAC and AFACx in the context of preconditioning Krylov methods.
Author: Bobby Philip, Oak Ridge National Lab, U.S.A

CS3: Contributed Session III

Inversion of quasi-separable Vandermonde-like matrices via displacement operator
Our interest is to explore not in just the inversion formula for quasiseparable Vandermonde matrices but in even more general class of quasiseparable Vandermonde-like matrices. Quasiseparable Vandermonde-like matrices generalize simple polynomials structure to the more general structures based on the concept of displacement. Matrices arising in displacement structure theory were called Vandermonde- like. This idea allowed one to nicely unify and significantly generalize all previous results. In this talk we observe that quasiseparable Vandermonde-like matrices satisfy Sylvester-type displacement equation. We explore the recurrence relations between columns of basis transformation matrix and generators of displacement operator to invert quasiseparable Vandermone-like matrices with $O(n^2)$ complexity which compares favorably with the cost of $O(n^3)$ of Gaussian elimination.
Authors: Sirani Perera and Vadim Olshevsky, University of Conneticut, U.S.A

Multivalued attractors, implicit Euler schemes and the Navier-Stokes equations
We present the theory of multivalued dynamical systems, with particular emphasis on the approximation of global attractors of continuous-time semigroups by discrete ones. As an application, we focus on a fully implicit time-discretization of the two-dimensional Navier-Stokes equations, establishing new uniform bounds on the time-step parameter. As a byproduct, we obtain a general long-time stability result and we prove the convergence of the discrete attractors to the continuous one as the time-step approaches zero.
Author: Michele C. Zelati, Indiana University, USA

Positive Stationary Solutions and Spreading Speeds of KPP Equations in Locally Spatially Inhomogeneous Media
The current paper is concerned with positive stationary solutions and spatial spread- ing speeds of KPP type evolution equations with random or nonlocal or discrete dispersal in locally spatially inhomogeneous media. It is shown that such an equation has a unique globally stable positive stationary solution and has a spreading speed in every direction. Moreover, it is shown that the localized spatial inhomogeneity of the medium neither slows down nor speeds up the spatial spreading in all the directions.
Authors: Liang Kong and Wenxian Shen, Auburn University, USA

Multi-GPU Solutions of Hyperbolic and Elliptic PDEs with RBF-FD
Radial Basis Function Finite Difference (RBF-FD) is a generalized FD scheme that functions on unstructured grids, has stability for large time-steps and competitive accuracy compared to other state-of-the-art methods. We present an ongoing effort to develop fast and efficient parallel implementations of RBF-FD for hyperbolic and elliptic PDEs in geophysics. This work targets Keeneland, an NSF funded GPU cluster with over three hundred GPUs.
Authors Evan F. Bollig, Gordon Erlebacher, Florida State University, USA; Natasha Flyer, National Center for Atmospheric Research (NCAR), USA

MS18: Recent Advances in Analysis of Partial Differential Equations - Part II of III

Self similar solutions in certain very degenerate parabolic equations
In this talk I will report initial results on a very degenerate parabolic equation and a forward-backward parabolic equation obtained using similarity solutions: For the total variation of equation, our new solutions allow for a rather fine estimate of the extinction time using a comparison theorem due to Bellettini, Caselles, and Novaga. In the case of the forward-backward parabolic equation we find the expected hysteretic behavior. In addition, for an unstable phase to exist it must be already

present in the initial data, and in the long term the stable phase always invades the unstable phase.
Author: Marrianne Korten, Kansas State University, USA

Equilibria and Stability of the Axisymmetric Surface Diffusion Flow
The surface diffusion ow is a fourth-order quasilinear evolution law which models the motion of some surfaces in the presence of high temperatures. I will focus on the setting of surfaces which exhibit symmetry about a fixed axis of rotation. In particular, I will discuss equilibria of the ow in this setting and analytic methods involved with stability/instability results.
Author: Jeremy LeCrone, Vanderbilt University, USA

A Harnack-type Inequality for a logarithmically singular parabolic equation
The local properties of non-negative weak solutions to the singular parabolic equation $u_t - \Delta \ln u = 0$ are largely unclear, though some research has been done for the Cauchy problem of such an equation. In this talk, we address the local positivity of this equation in the form of a Harnack-type inequality. Under the assumption that lnu is suffciently integrable, we show if u does not vanish identically in a space neighborhood of x_0 and on some time level t_0 then u is positive in a neighborhood of $(x_0; t_0)$.
Author: Naian Liao, Vanderbilt University, USA

Generalizations of p-Laplace equations
The p-Laplace equation provides the standard examples of degenerate equations (if $p > 2$) and singular equations (if $p < 2$). This talk will present an overview of other classes of degenerate and singular equations which include the p-Laplace equation as a special case.
Author: Gary Lieberman, Iowa State University, USA

Compressible Navier-Stokes Equations with Temperature Dependent Heat Conductivity
I will report some recent progress made on the theory for compressible Navier- Stokes equations when the heat conductivity depends on temperature in physical way. Global existence and regularity results were obtained in one space dimension. This is a joint work with W. Zhang
Author: Ronghua Pan, Georgia Institute of Technology, USA

MS19 Recent Advances in Numerical PDEs and Computational Biology - Parts II of III

A fast two-step finite difference method for two-dimensional space-fractional diffusion equations
Fractional diffusion equations model phenomena exhibiting anomalous diffusion that cannot be modeled accurately by the second-order diffusion equations. Because of the nonlocal property of fractional directional operators, the numerical methods for fractional diffusion equations often generate dense or even full coefficient matrices. Consequently, the numerical solution of these methods often require computational work of $O(N^3)$ per time step and memory of $O(N^2)$ for where N is the number of grid points. In this talk we present a fast two-step finite difference method for space-fractional diffusion equations in two space dimensions. The method only requires computational work of $O(N(log)^2N)$ per time step and memory of $O(N)$, while retaining the same accuracy and approximation property as the regular finite difference method with Gaussian elimination. Our numerical example runs for two dimensional model problem of intermediate size show the following observations: To achieve the same accuracy, the new method has a significant reduction of the CPU time from more than 2 months and 1 week consumed by a traditional finite difference method to 1.5 hours, using less than one thousandth of memory the standard method does. This demonstrates the utility of the method.
Author: H. Wang, University of South Carolina, USA

Intermittent diffusion for global optimizations
I will present an intermittent diffusion (ID) method to find global minimizers of a given function. The main idea is to add intermittent,instead of continuously diminishing, random perturbations to the gradient flow generated by the function, so that the trajectories can quickly escape from one minimizer and approach other minimizers. Its Fokker-Planck equation, which characterizes the dynamics of the probability density function of the trajectories, changes between hyperbolic and parabolic in time. The method is inspired by some remarkable methods including simulated annealing, the global diffusion for optimizations, and some recent progress in random dynamical systems. Numerical simulations show that the proposed method achieves significant improvements in terms of the fastest time of reaching the global minimizers and the frequency of visiting global minimizers over the existing global optimization algorithms. This talk is based on a collection of projects in collaboration with Shui-Nee Chow (Georgia Tech), Jun Lu (Georgia Tech) and Tzi-Sheng Yang (Tunghai).
Author: H. Zhou, Georgia Institute of Technology, USA

Pattern Formation on Spheroidal Surfaces and their Finite Element Approximation
Pattern formation on surfaces and on evolving (growing) surfaces can be modeled with reaction diffusion systems. Such pattern formation occurs naturally in various biological systems e.g., seashells, tropical fish, animal furs and skins, growing tumors, and cell membranes. We describe a finite element method (radially projected finite elements) for approximating solutions of such reaction diffusion equations which are posed on spheroidal surfaces, and on growing spheroidal surfaces. We present some results from numerical experiments.
Author: Amnon J. Meir, Auburn University, USA

Recent Development of Hierarchical Reconstruction for Limiting on DG and Finite Volume Schemes
Hierarchical reconstruction does not use local characteristic decomposition, is compact and can be formulated on unstructured meshes naturally. It decomposes the job of limiting a high degree polynomial defined in a cell into a series of smaller jobs, each of which only involves the non-oscillatory reconstruction of a linear polynomial from cell averages. It has been successfully applied to 3rd order DG on triangular meshes (with partial neighboring cells) and to 4th order DG on triangular meshes (in a point-valued version). I am going to review some of the successful techniques and discuss recent development.
Author: Y. Liu, Georgia Institute of Technology, USA

MS 20 Advances in Inverse Problems - Part II of II

Spectral properties of the Lax operator for the matrix nonlinear Schrodinger system
We discuss the spectral properties of the AKNS system associated with the matrix nonlinear Schrodinger system. In particular, we consider systems whose coefficients have nonvanishing and different asymptotics as $x \to +\infty$ or $-\infty$. The main topics to be studied concern the location of the continuous spectrum and the existence of discrete and embedded eigenvalues, and we pay special attention to spectral singularities (resonances). As we will see, the spectral properties of AKNS systems of order greater than two give rise to various new problems and challenges not encountered in the standard 2x2 case.
Authors: Martin Klaus, Virginia Tech, USA

Stability of the inverse resonance problem on the whole line
In the absence of a half-bound state, a compactly supported potential of a Schrodinger operator on the line is determined up to a translation by the zeros and poles of the meropmorphically continued

left (or right) reflection coefficient. The poles are the eigenvalues and resonances, while the zeros also are physically relevant. We prove that all compactly supported potentials (without half-bound states) that have reflection coefficients whose zeros and poles are ?-close in some disk centered at the origin are also close (in a suitable sense). In addition, we prove stability of small perturbations of the zero potential (which has a half-bound state) from only the eigenvalues and resonances of the perturbation.
Author: Matthew Bledsoe, University of Alabama at Birmingham, USA

The inverse volatility problem for American options
The inverse problem of computing the volatility function from published prices of options at various maturities and strike prices is of interest as it gives us a market view of the future. There are many methods available for the European option case, but few for the more ubiquitous American options. We introduce an optimization approach to this problem using the minimization of certain convex functionals.
Authors: Ian Knowles and Ajay Mahato, University of Alabama in Birmingham, USA

MS 21 Modeling, Simulation, and Analysis of Phase-field Method in Various Science Fields of Current Interests - Part II of III

Phase field method for biological microstructures
Phase field method has become a widely used tool to characterize the evolution of surfaces in material science, biology, imaging processing, etc. In this talk the speaker presents how to apply phase field method to the evolution of biological microstructures. The content includes the study of the equilibrium shape of lipid vesicles, multicomponent vesicles, actomyosin driven cell oscillations.
Author: Xiaoqiang Wang, Florida State University, USA

Mathematical Analysis and Diffusive Interface Modeling of Membrane Movements
The role of a biological membrane is to act as a barrier between ionic solutions. One way life controls ionic solution is through ion channels. A second more drastic way is by introducing a hole in the membrane itself. For example, in hemolysis, the osmotic swelling and rupture of a red-blood cell, a single hole forms in the membrane leading to the leak out of the contents of the cell. Similarly, in exocytosis a hole is formed by joining to membrane bilayers. These processes are mathematically challenging to study because they involve physical forces on multiple scales and predicting the time course is more consequential than the equilibrium end states. This talk will show how such complicated fluid mechanical problems yield to quantitative modeling and simulation when using the diffusive interface and energetic approach.
Author: Rolf Ryham, Forham University, USA

A phase field model for moving contact lines and its application to electrowetting
We consider a diffuse interface model aimed at addressing the movement of three-phase (fluid-fluid-solid) contact lines. The model consists of the Cahn Hilliard Navier Stokes system with a variant of the Navier slip boundary conditions. We show that this model possesses a natural energy law. For this system, a new numerical technique based on operator splitting and fractional time-stepping is proposed. As an application, we introduce a new model for the problem of electrowetting on dielectric for which we discuss discretization techniques.
Author: Abner J. Salgado, University of Maryland, USA

Global regularity and stability of a hydrodynamic system modeling vesicle and fluid interactions
We study a 3D hydrodynamical system modeling the deformation of vesicle membranes in incompressible viscous fluids. We prove the existence/uniqueness of local strong solutions for arbitrary initial data as well as global strong solutions under the large viscosity assumption. We also establish some regularity criteria in terms of the velocity for local smooth solutions. Finally, we study

the stability of the system near local minimizers of the elastic bending energy.
Author: Xiang Xu, Carnegie Mellon University, USA

MS22 Structural and Extremal Graph Theory

Linear Choosability of Sparse Graphs

We study the linear list chromatic number, denoted $\lceil(G)$, of sparse graphs. The maximum average degree of a graph G, denoted $mad(G)$, is the maximum of the average degrees of all subgraphs of G. defined by $mad(G) = \max_{H \subseteq G} \frac{2|E(H)|}{|V(H)|}$. It is clear that any graph G with maximum degree $\Delta(G)$ satisfies $\lceil(G) \geq \lceil \Delta(G)/2 \rceil + 1$. In this paper, we prove the following results: (1) if $mad(G) < \frac{12}{5}$ and $\Delta(G) \geq 3$, then $\lceil(G) = \lceil \Delta(G)/2 \rceil + 1$, and we give an infinite family of examples to show that this result is best possible; (2) if $mad(G) < 3$ and $\Delta(G) \geq 9$, then $\lceil(G) \leq \lceil \Delta(G)/2 \rceil + 2$, and we give an infinite family of examples to show that the bound on $mad(G)$ cannot be increased in general; (3) if G is planar and has girth at least 5, then $\lceil(G) \leq \lceil \Delta(G)/2 \rceil + 4$. This is joint work with Dan Cranston.
Author: Gexin Yu, College of William and Mary, USA

The Minimum Randic Index of Cyclic Graphs with K Pendant Vertices

The Randic Index of a graph is a topological index often used in the chemical graph theory. One may find lower and upper bounds of the Randic Index for particular classes of graphs. In this talk I will discuss some general results pertaining to the lower bound of the Randic Index for classes of graphs with at least one cycle and k pendant vertices. I will also discuss implications for unicyclic, and bicyclic graphs.
Author: Jeffrey Pair, Middle Tennessee State University, USA

On Maximum Edge Cuts of Connected Digraphs

If (X, Y) is a partition of the vertex set of a digraph D, then the set of all edges directed from X to Y is called a *directed cut* of D. Let $\Lambda(D)$ denote the size of maximum directed cuts of D. For any two positive integer k and ℓ, let $\mathcal{D}(k, \ell)$ denote the set of digraphs D such that for each vertex $v \in V(D)$ either $d^+(v) \leq k$ or $d^-(v) \leq \ell$, where $d^+(v)$ and $d^-(v)$ are the outdegree and indegree of v, respectively. The class $\mathcal{D}(1, 1)$ is a nature extension of the set of subcubic digraphs. Lehel, Maffary, and Preissmann recently studied graphs in $\mathcal{D}(k, \ell)$ comprehensively and they proved the following two results:

- $\Lambda(D) \geq \frac{7}{20}|E(D)|$ for every connected digraph $D \in \mathcal{D}(1, 1)$, unless D is a directed triangle; moreover
- $\Lambda(D) \geq \frac{2}{5}(|E(D)| - t)$ for every connected digraph $D \in \mathcal{D}(1, 1)$ with at most t vertex disjoint directed triangles.

Xu and Yu characterized the acyclic digraphs in $\mathcal{D}(1, 1)$ with $\Lambda(D) = \frac{2}{5} \times |E(D)|$. We show that $\Lambda(D) \geq \frac{3|E(D)|-1}{8}$ for every connected digraph $D \in \mathcal{D}(1, 1)$, which provides a positive answer to a problem of Lehel, Maffray and Preissmann. Additionally, we consider triangle-free digraphs in $\mathcal{D}(1, 1)$ and answer their another question. Joint work with M. Gu and N. Li
Author: Guantao Chen, Georgia State University, USA

Nowhere-zero 3-flows of Graphs and Odd Edge Cuts

The concept of integer flow was originally introduced by Tutte in 1949 as a generalization of map coloring problems. We investigate the role that odd edge cuts play in nowhere-zero 3-flows and prove that for each odd integer $k \geq 3$, if the size of every odd edge cut of a graph G is in $\{k, k+2, \cdots, 3k-2\}$, then G admits a nowhere-zero 3-flow if and only if G can not be reduced to three well-defined families of graphs. This is joint work with Rui Xu, Zhengke Miao, and CQ Zhang.
Author: Rong Luo, Middle Tennessee State University

(5,2)-configuration on minimum degree at least two $K_{1,6}$-free graphs
A function f is called a $(5,2)$-*configuration function* for a graph G if $f : V(G) \rightarrow [5]_2$ satisfies that $\cup_{u \in N[v]} f(u) = \{1,2,3,4,5\}$ for all $v \in V(G)$, where $N[v] = \{v, u : uv \in E(G)\}$ and $[5]_2$ is the collection of all 2-subsets of $\{1,2,3,4,5\}$. Fujita, Yamashita and Kameda showed that every 3-regular graph has a $(5,2)$-configuration function. In this paper, we prove that besides four exception graphs, every $K_{1,6}$-free graphs of minimum degree at least two has a $(5,2)$-configuration function. This is joint work with Robin Thomas and Peter Whalen.
Author: Chun-Hung Liu, Georgia Tech, USA

MS23 Asymptotic Dynamics of Dissipative Evolution Equations - Part II of III

Traveling water waves with compactly supported vorticity
We consider the water wave problem and construct small traveling wave solutions with vorticity based on a bifurcation method. The vorticity of these solutions are supported in a small domain away from the water surface. This is a joint work with Jalal Shatah and Sam Walsh.
Author: C. Zeng, Georgia Institute of Technology, USA

Shape memory alloys, anti-diffusion lattice equations, and traveling checkerboards
In this talk we present a simple model for phase transitions that occur for example in shape memory alloys that results in a lattice Nagumo equation with anti-diffusion. We investigate traveling wave solutions by transforming to a periodic media problem and uncover rich dynamics. In higher space dimensions similar techniques are effective for propagation in rational directions and we discuss some work in progress to obtain existence in irrational directions. This talk is based upon previous work with Anna Vainchtein, recent work with Maila Brucal, and work in progress with Hermen Jan Hupkes.
Author: E.V. Vleck, University of Kansas, USA

Upscaling chaotic dynamics in porous media via central limit theorems
There are several upscaling (renormalization) techniques for transport in porous media. All approaches in Statistical Mechanics except the upscaling tool via central limit theorems (CLT) use second moments. When Levy motions are applied to microbial chaotic dynamics and fluid flow in porous media, CLT plays significant roles in modeling transport in porous media. Because non-Gaussian Levy motions have infinite second moments. In this talk, the stochastic modeling and Fokker-Planck equations will be presented. The renormalized Fokker-Planck equations are evolution equations which are averaged in small scales.
Author: M. Park, University of Alabama in Huntsville, USA

Evolution of Mixed Dispersal in Periodic Environments
Random dispersal describes the movement of organisms between adjacent spatial locations. However, the movement of some organisms such as seeds of plants can occur between non-adjacent spatial locations and is thus non-local. We propose to study a mixed dispersal strategy, which is a combination of random dispersal and non-local dispersal. More specifically, we assume that a fraction of individuals in the population adopt random dispersal, while the remaining fraction assumes non-local dispersal. We investigate how such mixed dispersal affects the invasion of a single species and also how mixed dispersal strategy will evolve in spatially heterogeneous but temporally constant environment.
Author: W. Shen, Auburn University, USA

MS24 Modeling Complex Biological Systems: Theoretical and Computational Studies - Part II of III

Multiphase modeling of hydrogels and its application to bacterial biofilms

I will present a multiphase modeling paradigm for multiphase complex fluids consisting of viscous buffer fluid and viscoelastic hydrogels. A suite of models are then derived for studying biofilms and buffer fluid interaction in various geometry and time scale. The intrinsic instability and the nonlinear reactive dynamics can be coupled to create patterns of growth and heterogeneity in biofilm-fluid mixtures. 3-D numerical simulations will be presented to demonstrate the usefulness of the models.

Author: Q. Wang, University of South Carolina, USA

Generalized image charge solvation model for electrostatic interactions in molecular dynamics simulations of aqueous solutions

I will discuss the extension of the image charge solvation model (ICSM) [J. Chem. Phys. 131, 154103 (2009)], a hybrid explicit/implicit method to treat electrostatic interactions in computer simulations of biomolecules formulated for spherical cavities, to prolate spheroidal and triaxial ellipsoidal cavities, designed to better accommodate non-spherical solutes in molecular dynamics (MD) simulations. In addition to the utilization of a general truncated octahedron as the MD simulation box, central to the proposed extension is the computation of reaction fields in an one-image approximation for non-spherical objects. The resulting generalized image charge solvation model (GICSM) is tested in simulations of liquid water, and the results are analyzed in comparison with those obtained from the ICSM simulations as a reference.

Author: S. Deng University of North Carolina at Charlotte, USA

An agent-based model of mosquito host localization through odor plume finding and tracking

Mosquito host-seeking behavior and heterogeneity in the distribution of hosts are important factors in predicting the transmission dynamics of mosquito-borne infections such as West Nile virus. My co-authors and I are interested in quantifying the impact of such small scale heterogeneity on the contact rate between mosquitoes and hosts. I present our agent-based model of mosquito host-seeking behavior in which mosquito agents navigate in a two-dimensional space and respond to wind and to carbon dioxide that is steadily emitted from stationary hosts. The scenario inspiring the parameter choices is that of Culex quinquefasciatus mosquitoes preying on roosting birds at night. The exhaled carbon dioxide from the sleeping birds forms an odor plume in the wind, which we simulate using an advection-diffusion equation. I discuss the effectiveness of different mosquito navigation strategies with respect to both wind and carbon dioxide, the effect of having more than one host patch, and the effect of changing host density. Overall, our simulations indicate that small-scale heterogeneity in host distribution and mosquito behavior leads to noticeable changes in contact rate. I present our first attempt to use these results to inform parameter choices in compartmental epidemiology models.

Author: B. Cummins, Tulane University, USA.

WENO computations and pattern formation of a chemotactic cell movement model

Chemotaxis is the phenomenon in which cells or organisms direct their movements according to certain gradients of chemicals in their environment. Chemotaxis plays an important role in many biological processes, such as bacterial aggregation, early vascular network formation, among others. In this talk, I shall present our recent studies on the dynamics, pattern structures and robustness of a biologically realistic macroscopic nonlinear mathematical model of chemotactic cell movements using high resolution numerical simulations. We show that the model can form network patterns similar to early blood vessel structures seen experimentally. The model solutions do not blow up in finite time, a property of other chemotaxis cell movement models. We developed high order

weighted essentially non-oscillatory (WENO) schemes for solving the nonlinear chemotaxis models. While WENO schemes on structured meshes are quite mature, the development of finite volume WENO schemes on unstructured meshes is more difficult. A major difficulty is how to design a robust WENO reconstruction procedure to deal with distorted local mesh geometries or degenerate cases when the mesh quality varies for complex domain geometry. In this work, we combined two different WENO reconstruction approaches to achieve a robust unstructured finite volume WENO reconstruction on complex mesh geometries.
Author: Y.T. Zhang, University of Notre Dame, USA.

Mathematical Model for Two Germline Stem Cells Competing for Niche Occupancy
In the Drosophila germline stem cell ovary niche, two stem cells compete with each other for niche occupancy to maintain stem cell quality by ensuring that dierentiated stem cells are rapidly pushed out the niche and replenished by normal ones. To gain a deeper understanding of this biological phenomenon, we have derived a mathematical model for explaining the physical interactions between two stem cells. The model is a system of two nonlinear rst order and one second order dierential equations coupled with E-cadherins expression levels. The model can explain the dynamics of the competition process of two germline stem cells and may help to reveal missing information obtained from experimental results. The model predicts several qualitative features in the competition process, which may help to design rational experiments for a better understanding of the stem cell competition process.
Authors: J.P. Tian, College of William and Mary, USA; Zhigang Jin and Ting Xie, Stowers Institue for Medical Reseach, USA.

MS25 High order numerical approximations to partial differential equations

A partition of unity radial basis function collocation method for partial differential equations
We propose a partition of unity approach where radial basis function approximation is employed within each partition. The introduced locality reduces both memory usage and computational cost compared with the global method. In order to achieve numerical convergence, we use stable evaluation of the approximant for nearly flat kernels using RBF-QR algorithm (Fornberg, Larsson, Flyer 2011). We will show numerical experiments in solving 2D Poisson Equation where spectral or algebraic convergence can be achieved.
Author: Ala Heryudono, University of Massachusetts Dartmouth, USA

Global in time numerical stability of pseudo-spectral schemes for nonlinear PDEs
Global in time stability of pseudo-spectral schemes for certain nonlinear PDEs, such as incompressible fluid flow and bi-stable gradient system, are presented in this talk. For incompressible Euler and Navier-Stokes equation, a global bound in L^2 norm for the numerical solution is obtained. For bi-stable gradient system, the convexity splitting nature of the numerical scheme assures its non-increasing energy. Some long time numerical simulations will also be presented.
Authors: Cheng Wang and Sigal Gottlieb, University of Massachusetts Dartmouth, USA.

Determining Critical Parameters of Sine-Gordon and Nonlinear Schrodinger Equations with a Point-Like Potential Using Generalized Polynomial Chaos Methods
We consider the sine-Gordon and nonlinear Schrodinger equations with a point-like potential and use the generalized polynomial chaos (gPC) method to find the critical velocity that determines the critical behavior of the soliton-pass or soliton-capture. The Galerkin and collocation gPC based on the Legendre and Hermite polynomials find the gPC mean for the critical velocity. Numerical results confirm the spectral convergence of the method.
Authors: Jae-Hun Jung, Debananda Chakraborty and Emmanuel Lorin SUNY Baffao, USA.

First and Second Order Unconditionally Energy Stable Schemes for the Nonlocal Cahn-Hilliard and Allen-Cahn Equations

In this talk I will present unconditionally energy stable schemes for the nonlocal Cahn-Hilliard and Allen-Cahn equations. I will briefly derive the nonlocal models and discuss the difference between the classical (local) and nonlocal CH and AC equations. Stability and convergence theorems of the schemes will be given. Also some numerical simulation results will be provided to show the convergence rates of the scheme and the simulation of the phase separation phenomena.
Authors: Zhen Guan, Steven Wise, University of Tennessee, USA; Cheng Wang, University of Massachusetts at Dartmouth, USA.

MS26 Numerical Methods for Incompressible Flow Problems - Part II of II

Approximation of viscoelastic fluid flows with defective boundary conditions

We investigate numerical algorithms for viscoelastic fluid flows with defective boundary conditions, where only flow rates or mean pressures are prescribed on parts of the boundary. The defective boundary condition problem is formulated as a minimization problem, where we seek boundary conditions of the flow equations which yield an optimal functional value. Two different approaches are considered in developing computational algorithms for the constrained optimization problem, and results of numerical experiments are presented to compare performance of the algorithms.
Author: Keith Galvin, Clemson University, USA

Numerical approximations of the Voigt regularization of incompressible Navier-Stokes and magnetohydrodynamics equations

We study numerical approximations to the Voigt regularization models of the incompressible Navier-Stokes (NSE) and magnetohydrodynamics (MHD) equations. We present finite element numerical schemes, which are linearized and enforce solenodial constraints exactly, for the two models. The methods are shown to be unconditionally stable and optimally accurate. We then verify the effectiveness of the numerical schemes by testing on benchmark problems.
Author: Nick Wilson, Clemson University, USA.

A variational approach for image-based parameter estimation in hemodynamics

Estimation of the stiffness of a biological soft tissue is useful for the detection of pathologies such as tumors or artheosclerotic plaques. One of the methods used to estimate such parameter is called elastography: a known force is applied to the tissue and the corresponding deformation is stored. An inverse elasticity problem is then solved to estimate the physical parameters, such as the Young modulus. In the case of arteries, there is already a natural force applied to the vessel, given by the action of the blood. However, since this force is not known, in order to estimate the Young modulus an inverse fluid-structure interaction (IFSI) problem needs to be solved. First, we introduce a variational approach to solve this problem, together with some well posedness results. A numerical analysis of synthetic problems with and without noise is then presented. Finally, we give some preliminary results of possible research directions aiming to cut down the high computational costs of the IFSI problem.
Author: Luca Bertagna, Emory University, USA.

A parallel fast solver for the 3-D Helmholtz integral operator in layered media

In this talk, a parallel fast algorithm to calculate Helmholtz integral operator in layered media will be presented. First, spectral Green's function is found using transfer matrix method and Sommerfeld integral is used to recover the real space Green's function. The Sommerfeld integral has two numerical difficulties: 1. Slow decay of the integrand and 2. existence of surface pole along the integral domain. Both problems are overcome with the window function and specially designed quadrature method with discrete wavelet transform, respectively. Then, the Helmholtz integral operator is calculated with discretized Sommerfeld integral using wideband Fast Multipole Method (wFMM) and local-expansion tree-codes in a fast and parallel manner. Numerical results

will be presented to show the efficiency of the new solver.
Author: Min H. Cho, University of North Carolina at Charlotte, USA

MS27 Advances in Free Boundary Problems - Part I of II

A Lagrangian method for low Reynolds number viscoelastic flow

I will discuss a numerical method for modeling viscoelastic fluid flow. A common set of viscoelastic fluids are polymer solutions composed of long chain molecules in a viscous solvent, often modeled by the Oldroyd-B constitutive equation. I consider the case in which fluid inertia is negligible, and present a regularized Lagrangian formulation of the Stokes-Oldroyd-B equations. This technique models immersed interfaces well, even low dimensional interfaces that cannot be handled by a singular Lagrangian formulation.
Authors: Bree Cummins, Tulane University, USA

Some simple techniques for the level-set interface capturing with the BFECC method

Using the BFECC method to compute the level set equation describing a free surface motion provides a simple and effective implementation of the level set method, because BFECC essentially calls a first order subroutine 3 times. It also has less smearing near sharp corners (with underlying CIR method) compared to many other 2nd order methods. I will discuss some techniques for BFECC to locally handle non-smooth convection velocity and a simple redistancing procedure.‘
Author: Yingjie Liu, Georgia Institute of Technology, USA

Operator splitting methods for stiff convection-reaction-diffusion equations

Implicit integration factor (IIF) method, a class of efficient semi-implicit temporal scheme, was introduced recently for stiff reaction-diffusion equations. Advection-reaction-diffusion equations are traditionally difficult to handle numerically. For reaction-diffusion systems with both stiff reaction and diffusion terms, implicit integration factor (IIF) method and its high dimensional analog compact form (cIIF) serve as an efficient class of time-stepping methods. For nonlinear hyperbolic equations, front tracking method is one of the most powerful tools to dynamically track the sharp interfaces. Meanwhile, weighted essentially non-oscillatory (WENO) methods are a class of start-of-the-art schemes with uniform high order of accuracy in smooth regions of the solution, which can also resolve the sharp gradient in accurate and essentially non-oscillatory (ENO) fashion. In this talk, IIF/cIIF is coupled with front tracking or WENO by the second-order symmetric operator splitting approach to solve advection-reaction-diffusion equations. In the methods, IIF/cIIF methods treat the stiff reaction-diffusion equations, and front tracking/WENO methods handle hyperbolic equations that arise from the advection part. In addition, we shall introduce a method for integrating IIF/cIIF with adaptive mesh refinement (AMR) to take advantage of the excellent stability condition for IIF/cIIF. The applications of these numerical methods to fluid mixing and cell signaling will also be presented.
Author: Xinfeng Liu, University of South Carolina, USA.

CS4: Contributed Session IV

Shadow Densities for Speeding the Execution and Evaluation of Kernel Machines

Kernel machines are class of manifold learning algorithms that rely on the spectral decomposition of an underlying density. The learning and execution costs scale with the size of the dataset, which can lead to poor execution speed in real-time systems. Exploiting the data redundancy typical of machine learning datasets and the nature of the Gaussian kernel, an approach to identifying and removing the redundancy is proposed, thus leading to more efficient execution.
Authors: Patricio Vela and Hassan Kingravi, Georgia Institute of Technology, USA

A Continuous Model for Gene Flow

Gene flow is a particularly interesting problem in population genetics. A common model for gene

flow is discrete randomly mating populations exchanging migrants each generation. Inferences on such a model are currently done by Markov Chain Monte Carlo. Current methods simulate discrete migration events in order to see how well genetic data matches a model and its parameters. There is little power to infer these events individually, and they are a nuisance parameter. What I propose is a new model of migration. In this model Gene Flow is modeled in a continuous matter using a non homogeneous Poisson process. Individual lineages no linger belong to a population but instead have a probability associated with each population. We hope that by turning this discrete problem into a continuous one we will be able to work with larger problems and more complicated scenarios.
Author: Michal Palczewski, Florida State University, U.S.A

A Discrete Regularity Result for a Linear Scheme for the Saturation Equation
We establish a (discrete) regularity result for a linear scheme approximating the saturation equation

$$\phi\frac{\partial S}{\partial t} + \nabla \cdot f(S)u - \nabla k(S) \cdot \nabla S = 0$$

under appropriate boundary and initial conditions. A linear scheme is obtained, at each time step, through first order Taylor expansions of the nonlinear terms appearing in the continuous Galerkin weak formulation of the problem. If $(u_h^n),\ 0 \leq n \leq N$ is the solution of the linear scheme, we show that

$$\max_{0\leq n\leq N-1} \|(u_h^{n+1} - u_h^n)/\Delta t\|_2^2 + \eta \max_{0\leq n\leq N-1} \|\nabla(u_h^{n+1} - u_h^n)/\Delta t\|_2^2 \leq (1+\Delta t)\delta^{-1}h^{-2}\,.$$

where η is some positive number, $\delta > 0$ is a regularization parameter, $h > 0$, the spatial discretization parameter, and Δt, the time stepping parameter.
Author: Koffi Fadimba, University of South Carolina at Aiken, USA.

Modeling financial markets with infinite dimensional stochastic systems
In this talk, we show convergence of solutions of stochastic differential systems with memory gap to those with full finite memory. More specifically, we obtain an approximation scheme for stochastic functional differential equations (SFDEs) whose coefficients have linear growth. In mathematical finance, a stock dynamics and option pricing formula with full finite memory are obtained.
Author: Flavia C. Sancier-Barbosa, Wittenberg University, USA

Most Likely Path to the shortfall risk in Long-Term Hedging with Short-Term Futures Contracts
Analysis and Management of financial risks is an important topic in Financial Mathematics. Our study is to find the most likely path to the shortfall risk in long-term hedging with short-term futures contracts. Base on a simple model initially discussed in Culp and Miller, Mello and Parsons, Glasserman and a simple discussion about comparing risks of a cash shortfall and the most likely path to a shortfall by Glasserman, we did analysis on the most likely path for four basic cases: mean reverting or not, hedged or not. In addition, based on Larcher and Leobacher's optimal strategy and Wu, Yu and Zheng's optimal strategy under the constraint of terminal risk, we did analysis on the most likely path corresponding to each optimal strategy. These "optimal" paths give information about how risky events occur and not just their probability of occurrence.
Author: Jing Chen, University of Alabama at Tuscaloosa, USA

IP3 Plenary Talk: Finite Element Methods for a Fourth Order Obstacle Problem
The obstacle problem for clamped Kirchhoff plates is a fourth order variational inequality. Its numerical analysis is subtler than the numerical analysis of the obstacle problem for elastic membranes, which is a second order variational inequality. This is due to the difference in the regularity of the solutions of these problems. For the membrane problem, the solution has full elliptic regularity. Therefore the complementarity form of the variational inequality exists in the strong sense and can be used to derive

optimal error estimates for finite element methods. However, the solution of the plate problem does not have full elliptic regularity. Therefore the complementarity form of the variational inequality only exists in a weak sense, and a convergence analysis based on the techniques developed for second order variational inequalities would only yield suboptimal error estimates. In this talk we present a new approach to the numerical analysis of plate obstacle problems that lead to optimal error estimates for C^1 finite element methods, classical nonconforming finite element methods, and discontinuous Galerkin methods. Applications of this new approach to related problems will also be discussed.
Author: Susanne C. Brenner, Louisiana State University, USA.

MS28 Recent Advances in Analysis of Partial Differential Equations - Part III of III

Stationary Navier-Stokes Equations With Critically Singular External Forces: Existence and Stability Results

We show the unique existence of solutions to stationary Navier-Stokes equations with small external forces belonging to a critical space. To the best of our knowledge, this is the largest critical space that is available up to now for this kind of existence. This result can be viewed as a stationary counterpart of an existence result obtained by H. Koch and D. Tataru for the free non-stationary Navier-Stokes equations with initial data in BMO-1. The stability of stationary solutions in such spaces will also be discussed. This talk is based on joint work with Tuoc Van Phan.
Author: Nguyen Phuc, Louisiana State University, USA.

On Well-posedness of Incompressible Two-phase Flows with Phase Transitions

A model for incompressible two-phase flows with phase transitions is derived from basic principles and shown to be thermodynamically consistent in the sense that the total energy is conserved and the total entropy is nondecreasing. Local well-posedness is proved by means of the technique of maximal L^p-regularity in the case of equal densities. This way we obtain a local semi flow on a well-defined nonlinear state manifold. The equilibria of the system in absence of external forces are identified and it is shown that the negative total entropy is a strict Liapunov functional for the system. If a solution does not develop singularities, it is proved that it exists globally in time, its orbit is relatively compact, and its limit set is nonempty and contained in the set of equilibria.
Author: Gieri Simonett, Vanderbilt University, USA

Local Holder Continuity for Doubly Nonlinear Parabolic Equations

We give a proof of the Holder continuity of weak solutions of certain degenerate doubly nonlinear parabolic equations. The analysis discriminates between large scales, for which a Harnack inequality is used, and small scales, that require intrinsic scaling methods. This is a joint work with Tuomo Kuusi and Juhana Siljander (Aalto University, Finland) that will soon appear in Indiana University Mathematics Journal.
Authors: Jose Miguel Urbano, Universidade de Coimbra, Portugal; Tuomo Kuusi and Juhana Siljander, Universidade de Coimbra, Portugal.

On Positive Solutions of Quasi-linear Elliptic Equations Involving Critical Sobolev Growth

We study the boundary value problem of the quasi-linear elliptic equation

$$div(|\nabla u|^{m-2}\nabla u) + f(x,u,\nabla u) = 0 \quad \text{in } \Omega$$

$$u = 0 \text{ on } \partial\Omega\,.$$

where $\Omega \subset \mathbb{R}^n$ $(n \geq 2)$ is a connected smooth domain, and the exponent $m \in (1,n)$ is a positive number. Under appropriate conditions on the function f, a variety of results on existence and non-existence of positive solutions have been established. This paper is a continuation of an earlier work of the author and, in particular, extends earlier results of Brezis and Nirenberg for the semilinear

case of $m = 2$, and of Pucci and Serrin.
Author: H. Zou, University of Alabama in Birmingham, USA.

MS29 Computational Accelerators - Algorithms on Non-traditional Hardware

Solving the Heat Equation using the Finite Element Method and Field Programmable Gate Arrays

We demonstrate the use of field programmable gate arrays (FPGA's) to solve the heat equation using a finite element algorithm (FEM). The structure of a high level language FEM code is transformed into a finite state machine using a "C" like syntax. The resulting linear algebra at the element and global level is transformed into a suitable hardware description language. The result is a hardware device suitable for control or operation of a process based on the heat equation.
Authors: Andy Scott, Alabama A and M University, USA and Phil Bording, Wave Research, USA

Image Processing using Field Programmable Gate Arrays

Image processing using field programmable gate arrays (FPGA's) is an essential product in the market place. Using upscaling and down scaling algorithms it is possible to compress and expand images. These image transformations have been implemented in hardware and will be demonstrated. The linear algebra for the methods used will be reviewed as well as the changes needed for implementation in hardware.
Authors: Shealia Burton, Alxavier Peebles, Jennifer Little, Rachel Hall, Shealia Burton, Kendon Lane, Andy Scott, and K. Heidary, Alabama A and M University; Phil Bording, Wave Research.

Applying a Genetic Algorithm to Reconfigurable Hardware using a Traditional HDL Approach

We present a case study using a genetic algorithm to efficiently solve traveling salesman problem with the inherent concurrency of a Field Programmable Gate Array (FPGA). This work utilized the experimental high-level hardware description language, Viva, by Starbridge Corp. The focus of this research is to port this high level design to a traditional hardware description language, VHDL, then using FPGA hardware technology to compare to traditional software based solutions on modern single-core computing environments.
Authors: Jessica Mintz and B. Earl Wells, University of Alabama in Huntsville.

Space Weather Phenomena Simulation using a Graphics Processing Unit

Space weather studies use modeling and simulation of the electromagnetic behavior of space weather phenomena and this is very compute intensive. For validation the results of these simulations are compared to empirical data collected from satellite observations. To minimize the amount of computation required to effectively simulate the phenomena and to facilitate parallel processing, Particle-in-Cell, PIC, techniques have often been employed. We discuss the implementation of the PIC method on graphics processing units, GPU's.
Authors: Nagendra Singh, Patrick Gilbert, Scotty Bridges, Jason Schansman, Frank Richard, and B. Earl Wells, University of Alabama in Huntsville, USA

MS30 Applied and Computational Harmonic Analysis - Part III of III

Necessary and Sufficient Conditions to Perform Spectral Tetris

Spectral tetris has proven to be one of the most powerful tools we have for constructing sparse frames and fusion frames for applications. But it is known that this method does not always work. We will discuss recent results of Casazza/Heinecke/Kornelson/Wang/Zhou which give necessary and sufficient conditions for spectral tetris constructions to work.
Author: Peter Casazza, University of Missouri, USA.

A Time-Frequency Localization Measure for Finite Frames

A measure for time-frequency localization inspired by the Heisenberg Uncertainty Principle and the Balian-Low Theorem is adapted for use in a finite frame setting. We find the minimizer of the measure over all equal norm Parseval frames and sharp quantitative bounds for the value of this measure. Inspired by the Sobolev dual, recently developed by Blum, Lammers, Powell and Yilmaz for use in Sigma Delta quantization, we produce a dual frame that minimizes this time-frequency measure. Finally, we present some preliminary findings on a Balian-Low Theorem for finite Gabor systems.

Author: Mark Lammers, University of North Carolina at Wilmington, USA

Gabor frames in amalgam spaces

We discuss several results on convergence of multiwindow Gabor frames in Wiener amalgam spaces. The talk is based on the joint work with R. Balan, J. Christensen, K.Okoudjou, and J.-L. Romero.

Author: Ilya Krishtal Northern Illinois University, USA

Almost sure convergence for the Kaczmarz algorithm with random measurements

The Kaczmarz algorithm is an iterative method for reconstructing a signal from an overcomplete collection of linear measurements. We prove quantitative bounds on the rate of almost sure exponential convergence in the Kaczmarz algorithm for suitable classes of random measurement vectors. Refined convergence results are given for the special case when each measurement vector has i.i.d. Gaussian entries and, more generally, when each normalized measurement vector is uniformly distributed on the unit-sphere. This work on almost sure convergence complements the mean squared error analysis of Strohmer and Vershynin for randomized versions of the Kaczmarz algorithm. This is joint work with Alex Powell.

Author: X. Chen, Vanderbilt University, USA

MS31 Discontinuous Galerkin Methods - Part II of II

An analysis of the practical DPG method

In this work we give a complete error analysis of the Discontinuous Petrov Galerkin (DPG) method, accounting for all the approximations made in its practical implementation. Specifically, we consider the DPG method that uses a trial space consisting of polynomials of degree p on each mesh element. Earlier works showed that there is a "trial-to-test" operator T, which when applied to the trial space, defines a test space that guarantees stability. In DPG formulations, this operator T is local: it can be applied element-by-element. However, an infinite dimensional problem on each mesh element needed to be solved to apply T. In practical computations, T is approximated using polynomials of some degree $r > p$ on each mesh element. We show that this approximation maintains optimal convergence rates, provided that $r \geq p + N$, where N is the space dimension (two or more), for the Laplace equation. We also prove a similar result for the DPG method for linear elasticity. Remarks on the conditioning of the stiffness matrix in DPG methods are also included. This is joint work with J. Gopalakrishnan.

Author: Weifeng Qiu, University of Minnesota, USA

Domain decomposition preconditioners for the discontinuous Petrov-Galerkin method

The discontinuous Petrov-Galerkin method allows for use of nearly optimal test functions at a reasonable computational cost, because the test functions can be solved for locally. The resulting methods can be very effective and show good stability properties, but solution of the resulting ill-conditioned linear systems is a challenge. We explore the effectiveness of domain decomposition preconditioning for linear systems arising from the DPG discretization, considering both their theoretical properties and their practical efficiency.

Author: Andrew Barker, Louisiana State University, USA

A nonoverlapping domain decomposition preconditioner for a symmetric interior penalty Galerkin method

In this talk we will discuss a nonoverlapping domain decomposition preconditioner for a symmetric interior penalty Galerkin method for the heterogeneous elliptic problem. The preconditioner is based on balancing domain decomposition by constraints. Theoretical results on the condition number estimate of the preconditioned system will be presented along with numerical results. This is joint work with Susanne C. Brenner and Li-yeng Sung.
Author: Eun Hee Park, Lousiana State University, USA

A Morley Finite Element Method for the Displacement Obstacle Problem of Clamped Kirchhoff Plates
The displacement obstacle problem of clamped Kirchhoff plates is an example of a fourth order variational inequality whose numerical analysis is more subtle than that of second order variational inequalities. In this talk we present a Morley finite element method for this problem. Both error estimates and numerical results will be discussed.
Author: Yi Zhang, Louisiana State University, USA

MS32 Modeling Complex Biological Systems: Theoretical and Computational Studies - Part III of III

CFD Prediction of Air Flow and Particle Transport in Large-Scale Human Lung Models
Predicting air flow and inhaled particle deposition in the human lung using computational fluid dynamics (CFD) is complicated by several factors. These include, but are not limited to, the need for anatomically correct airway geometries, the size and complexity of the bronchopulmonary tree, the time dependent nature of the flow field during cyclic breathing, and inherent accuracy and robustness limitations of particle phase models. Most CFD studies to date have focused on relatively small subsections of the bronchopulmonary tree and/or assumed steady inspiratory or expiratory flow, and have relied on Lagrangian particle tracking algorithms to predict the transport of all but nanoscale particulate matter. The Mississippi BioSim Cluster has initiated a project to develop an in silico model for prediction of particle fate in the human lung, which we have dubbed DigitalLung. Recent publications by our group have demonstrated the use of truncated airway geometries to dramatically reduce the computational expense of large-scale lung flow simulations to manageable levels, and have been shown to provide accurate predictions of airflow characteristics under steady-state and cyclic flow conditions. Further, the method has been coupled with realistic, CT-scan-based computational geometries in order to provide a realistic yet efficient CFD model of inhalation and exhalation. Finally, we have implemented stable, 2nd order accurate algorithms for Eulerian two-fluid modeling of the particle phase. This talk will summarize the current state of the Digital Lung project and present results that highlight several of the new methods and models that have been developed as part of this effort.
Author: K. Walters, Mississippi State University, USA.

Treecode-Accelerated Boundary Integral Poisson-Boltzmann Solver
Solvation of biomolecules is a challenging problem in computational biophysics. Models that track explicit solvent molecules are extremely costly, and implicit solvent models based on the Poisson-Boltzmann (PB) equation provide an efficient alternative for computing solvent-solute interactions. Even so, PB solvers still encounter numerical difficulties stemming from the discontinuous dielectric constant across the molecular surface, the boundary condition at spatial infinity, and the presence of charge singularities representing the biomolecule. To address these issues, we present a linear PB solver employing a well-conditioned boundary integral formulation and GMRES iteration accelerated by a treecode algorithm. The accuracy and efficiency of the method are assessed for the Kirkwood sphere and a solvated protein (PDB:1A63). We compare numerical results for both the Poisson-Boltzmann and Poisson equations, using the proposed treecode-accelerated boundary integral solver, as well as the mesh-based Adaptive Poisson-Boltzmann (APBS) method. The

present scheme has the features of relatively simple implementation, efficient memory usage, and straightforward parallelization.
Author: W. Geng, University of Alabama in Tuscaloosa, USA

Computational studies for cell signaling with scaffold
I will present a computational analysis of cell signaling in biology and medicine. Scaffold, a class of proteins, plays many important roles in signal transduction. Through studying various models of scaffold, I will show novel regulations induced by its spatial location and switch-like responses due to scaffold. To efficiently compute the models, we introduce a new fast numerical algorithm incorporated with adaptive mesh refinement for solving the stiff systems with spatial dynamics.
Authors: X. Liu, University of South Carolina, USA

Multiscale Model of Mucus Penetration in the Lung
Mucociliary transport (MT) is a complex dynamical process which involves interaction of the mucus layer with viscoelastic properties and the periciliary layer, a Newtonian fluid. It has been observed that MT will be more efficient when the ciliary tips in the effective stroke 'penetrate' the mucus and 'claw' it forward. Normal MT maintains healthy respiratory system while dysfunctions of MT are associated with many lung diseases. We develop a multiscale model to simulate the mucus penetration in the process of MT. This model couples the fluid dynamics and internal force generation induced by ATP motor proteins.
Authors: X. Yang, Mississippi State University, USA; Lisa Fauci, Tulane University, USA; Robert Dillon, Washington State University, USA.

MS33: Recent Advances in Numerical PDEs and Computational Biology - Part III of III

A Two Level Additive Schwarz Preconditioner for C0 Interior Penalty Methods for Cahn-Hilliard Equation
We study a two-level additive Schwarz preconditioner for C^0 interior penalty methods for a biharmonic problem with essential and natural boundary conditions with Cahn-Hilliard type. We show that the condition number of the preconditioned system is bounded by $C(1 + (H3/\delta^3)$, where H is the typical diameter of a subdomain, δ measures the overlap among the subdomains, and the positive constant C is independent of the mesh sizes and the number of subdomains.
Author: Kening Wang, University of North Florida, USA.

Time dependent problem of porous media with nonlinear permeability
I'm going to talk about a coupled system describing the diffusion in poro-elastic media. It is a quasi-static problem. The first equation is elliptic, linear, while the second equation is time dependent with a nonlinear generator. I'll give the well-posedness as well as the convergence of finite element method approach. I also have some numerical results to show.
Author: S. Chen, Auburn University, USA.

Error Analysis of a Stochastic Collocation Method for Parabolic Partial Differential Equations with Random Input Data
Integration factor methods are a class of "exactly linear part" time discretization methods. Recently, a class of efficient implicit integration factor (IIF) methods were developed for solving systems with both stiff linear and nonlinear terms, arising from spatial discretization of time-dependent partial differential equations (PDEs) with linear high order terms and stiff lower order nonlinear terms. The tremendous challenge in applying IIF temporal discretization for PDEs on high spatial dimensions is how to evaluate the matrix exponential operator efficiently. For spatial discretization on unstructured meshes to solve PDEs on complex geometrical domains, how to efficiently apply the IIF temporal discretization was open. In this talk, I will present our results in solving this problem by applying the Krylov subspace approximations to the matrix exponential

operator. Then we apply this novel time discretization technique to discontinuous Galerkin (DG) methods on unstructured meshes for solving reaction-diffusion equations. Numerical examples are shown to demonstrate the accuracy, efficiency and robustness of the method in resolving the stiffness of the DG spatial operator for reaction-diffusion PDEs. Application of the method to mathematical models in pattern formation shall be shown.
Author: Y. Zhang, Florida State University, USA.

Forward Backward Doubly Stochastic Differential Equations and applications to The Optimal Filtering problem
We consider the classical filter problem where a signal process is modeled by a stochastic differential equation and the observation is perturbed by a white noise. The goal is to find the best estimation of the signal process based on the observation. Kalman Filter, Particle Filter, Zakai equations are some well known approaches to solve optimal filter problems. In this talk, we shall show the optimal filter problem can also be solved using forward backward doubly stochastic differential equations. Both theoretical results and numerical experiments will be presented.
Author: B. Feng, Auburn University, USA.

MS34 Modeling, Simulation, and Analysis of Phase-field Method in Various Science Fields of Current Interests - Part III of III

A comparison study of phase-field models for an immiscible binary mixture with surfactant
The Ginzburg-Landau free energy functional with two order parameters has been widely used to describe surfactant adsorption at the interface between two immiscible fluids such as oil and water. To model surfactant adsorption, some functionals are added to the original free energy functional which represents an immiscible binary mixture. In this paper, we study the dynamics of an immiscible binary mixture with surfactant using a phase-field model with some functionals. The system is solved by a fast numerical method such as a multigrid method. For each additional functional, we demonstrate effects of parameters for an immiscible binary mixture with surfactant. Moreover, we consider nonphysical pheonomena when the unsuitable parameter values are used in additional functionals.
Author: Ana Yun, Korea University, Republic of Korea.

The self-similar evolution of a precipitate in elastic media
In this talk, we present a linear theory and nonlinear simulations to study the self-similar growth and shrinkage of a precipitate in an elastic media. This work is motivated by a series of studies by Li *et. al*, where the existence and morphological stability of self-similar crystals were demonstrated in a diffusion field. Here, we extend the theory and simulations into solid-state phase transformations where elasticity plays an important role in regularizing the evolution of the precipitate. For given applied stress boundary conditions, we show that depending on the mass flux entering/exiting the system, there exist critical scaling of flux and elasticity at which compact self-similar growth/shrinkage occurs in the linear regime. We then develop a spectrally accurate boundary integral method combined with a time-space adaptive rescaling scheme to investigate the nonlinear morphological stability of these self-similar precipitates. To speed up the calculation, we develop an adaptive treecode scheme for solving the integral equations. Our numerical results reveal that at long times there exists nonlinear stabilization that leads the precipitate to compact universal limiting shapes selected by the applied stress and mass diffusion flux. These theoretical and numerical results suggest that the classical Mullins-Sekerka instability, which drives the precipitate evolving into dendritic or dense-branching morphologies, can be controlled. It is a joint work with Shuwang Li, Xiaofan Li, Hualong Feng, and John Lowengrub.
Author: Amlan Barua, University of Illinois at Chicago, USA.

Phase-field simulations of dynamic wetting of viscoelastic fluids
In this work, we use a phase-field method to investigate the moving contact line between a viscoelastic fluid, a Newtonian fluid, and a solid substrate. The governing equations are solved by a finite element method on an adaptive triangular mesh. In a small region near the contact line, the flow field features a strong shear, which effects a high polymer stress even at a relatively low wetting speed. Viscous bending of the interface is therefore enhanced when the advancing fluid is viscoelastic. The results agree qualitatively with the experimental observations.
Author: Peng Tao Yue, Virginia Tech, USA.

Unconditionally pseudo-energy stable numerical schemes for the modified phase field crystal (MPFC) equation
Both the first and second order accurate convexity splitting schemes for the Modified Phase Field Crystal equation, a generalized damped wave equation for which the usual Phase Field Crystal equation is a special degenerate case, are presented in the talk. Both schemes are proven to be unconditionally pseudo-energy stable. In addition, they are non-linear at the level of the implicit time discretization but represent gradients of convex functionals and can be solved uniquely for any time step. Numerical results are presented to demonstrate the accuracy, energy stability and the efficiency of the schemes. The relaxation properties of the MPFC model, compared with the standard PFC model, are observed in the numerical simulation.
Author: Cheng Wang, UMass at Dartmouth, USA.

MS35 Asymptotic Dynamics of Dissipative Evolution Equations - Part III of III

Convergence versus periodicity in single-loop positive-feedback systems arising in the study of higher-order elliptic PDEs
Trying to understand the blow-up behavior of large radial solutions of polyharmonic PDEs with power nonlinearities, one is led to analyze the dynamics of certain parameter-dependent single-loop positive-feedback systems (in the sense of Selgrade); the dimension of the system corresponds to the order of the PDE. In low dimensions, one observes convergence to equilibrium; in high dimensions, multiple periodic orbits arise via successive Hopf bifurcations. We discuss the dynamics and consequences for the underlying PDEs.
Author: P. Schmidt, Auburn University, USA.

Global dynamics of a mathematical model for malaria transmission
We study a mathematical model for malaria transmission with variable human and mosquito populations. We investigate the global dynamics of the model with/without diffusion terms. The traveling wave solutions will also be discussed.
Author: S. Ai, University of Alabama in Huntsville, USA.

Principal Eigenvalues of Dispersal Operators and Their Applications
In this talk, first we will introduce the principal eigenvalue theory for random, discrete and nonlocal dispersal operators. Then we will show their applications in studying stationary solutions and spreading speeds for the monostable equations in periodic environments. Finally we will show the effects of spatial variations on the principal eigenvalues of these dispersal operators and periodic boundary condition, and the effects of spatial variations and dispersal strategies on the spreading speeds of monostable equations.
Author: A. Zhang, University of Kansas, USA.

Traveling Wave Solutions for a Class of Predator-Prey Systems
We use a shooting method to show the existence of traveling wave fronts and to obtain an explicit expression of the minimum wave speed for a class of predator-prey systems. Our approach is a significant improvement of techniques introduced by Dunbar. The advantage of our method is that it does not need the notion of Wazewski's set used in Dunbars approach. Moreover, one

nontrivial step in Dunbar's approach is to show the boundedness of solutions in the Wazewski's set before the construction of a Liapunov function and the application of LaSalle's invariance Principle. In our approach, we first convert the equations for traveling wave solutions to a system of first order equations by a "non-traditional transformation". For this converted system, we are able to construct a Liapunov function. With the use of this Liapunov function we can give a straightforward proof of the boundedness of a relevant class of solutions that correspond to traveling wave fronts. Our method provides a more efficient way to study the existence of traveling wave solutions for more general predator-prey systems.
Author: W. Huang, University of Alabama in Huntsville, USA.

MS36 Peridynamics: Material Modeling Without Derivatives

Well-posedness of the Linear Peridynamic Model of Continuum Mechanics

We present a mathematical analysis of the basic equations of continuum mechanics given in the peridynamic (PD) formulation. This work focuses on the linear bond-based PD model for homogeneous materials where the corresponding integral PD operator allow a sign changing kernel. We analyze this operator and the function spaces associated with it. We prove the well-posedness of both the equilibrium equations, given as nonlocal boundary value problems with volume constraints, and the Cauchy problem of the time dependent equations of motion. (This is a joint work with Qiang Du.)
Author: Tadele Mengesha, Penn state University, USA.

Finite Element Methods for Peridynamics: A Tale of Many Quadratures

Peridynamics (PD) models are very robust in predicting both continuous and discontinuous phenomena, however, the numerical PD methods are not. We take a Finite Element approach with robust mixed continuous and discontinuous function basis in 1-D and 2-D. However, the numerical scheme requires approximation of double integrals over very unusual domains, for example arbitrary intersections of disks with triangles. The choice of quadrature is critical and convergent rules have to be built "on-the-fly".
Author: Miroslav Stoyanov, Oak Ridge National Laboratory, USA.

Numerical Methods for the Nonlocal Peridynamics Model

Numerical prediction of crack growth and damage are long-standing problems in computational mechanics. The difficulties inherent in these problems arise from the basic incompatibility of cracks with the partial differential equations that are used in the classical theory of solid mechanics. The peridynamic model attempts to unite the mathematical modeling of continuous media, cracks, and particles within a single framework. Relevant numerical experiments will be conducted to show the effectiveness of the proposed methods.
Author: X. Chen, Florida state University, USA

Convergence and Scaling of a Peridynamic Diffusion Equation In Multiple Dimensions

We present a nonlocal, derivative-free mathematical model that contains classical diffusion, fractional diffusion, and one-dimensional peridynamics as special cases. In this model, the dimensionality, interaction strength, and non-local extent are assumed to be controlled quantities. We solve the resulting equations using a meshfree method, and profile its accuracy and convergence properties as the controlled parameters and quadrature points are adjusted.
Author: Steven Henke, Florida state University, USA

MS37: Mathematical Modeling in Biomedicine

Modeling and Optimal Control of Immune Response of Renal Transplant Recipients

We consider the increasingly important and highly complex immunological control problem: control

of the dynamics of immunosuppression for organ transplant recipients. The goal in this problem is to maintain the delicate balance between over-suppression (where opportunistic latent viruses threaten the patient) and under-suppression (where rejection of the transplanted organ is probable). A mathematical model is formulated to describe the immune response to both viral infection and introduction of a donor kidney in a renal transplant recipient. The numerical results demonstrate that this initial model exhibits appropriate characteristics of primary infection and reactivation for immunosuppressed transplant recipients. In addition, we develop a computational framework for designing adaptive optimal treatment regimes with partial observations and low frequency sampling, where the state estimates are obtained by solving a second deterministic optimal tracking problem. Numerical results are given to illustrate the feasibility of this method in obtaining optimal treatment regimes with a balance between under-suppression and over-suppression of the immune system.
Authors: S. Hu, H.T. Banks North Carolina State University, USA; Taesoo Jang and Hee-Dae Kwon, Inha University, Republic of Korea

Using Mathematical Modeling to Assess the Efficacy of Oxygen for Problem Wounds: Use of Hyperbaric or Topical Oxygen Therapies

We extend a previously developed mathematical model (Schugart, R.C., Friedman, a., Zhao, R., Sen, C.K., Wound angiogenesis as a function of tissue oxygen tension: a mathematical model, PNAS USA 105: 2628 - 33, 2008) for acute wound healing to investigate the application of hyperbaric and topical oxygen therapies to treat acute, delayed, and chronic wounds. The mathematical model is a nonlinear system of partial differential equations, which describes the complex interactions in both space and time of inflammatory cells, endothelial cell tips, endothelial cell sprouts, fibroblasts, extracellular matrix, oxygen, and growth factors. The equations were solved in Matlab using pdepe. A sensitivity analysis was conducted on the model to identify the parameters that most affect the healing response. From the analysis, we identified oxygen uptake by inflammatory cells as a parameter that can create a delayed healing response, and the chemotactic response of inflammatory cells as a parameter that can create a chronic healing response, as defined by a persistence of inflammatory cells at the wound site. For the acute wound, our model suggests that hyperbaric oxygen heals the wound at a faster rate than topical oxygen therapy. For the delayed healing response, the wound healed better with topical oxygen than with hyperbaric oxygen therapy. For the chronic wound, both therapies decrease the inflammatory response and improve the healing response, with a slightly faster healing response for hyperbaric oxygen than topical oxygen therapy. The model suggests that the different therapies change the oxygen gradients in the wound, which affects how the wound heals. We conclude that mathematical models can not only provide potentially useful insights into the mechanisms that contribute to the healing response, but also suggest which therapeutic strategy might best heal the wound.
Authors: Richard Schugart, Western Kentucky University, USA; Jennifer Flegg, D.L.S. McElwain, Queensland University of Technology, Australia.

A Consensus Model for Electroencephalogram Data Via the S-Transform

A consensus model combines statistical methods with signal processing to create a better picture of the family of related signals. In this thesis we will consider 32 signals produced by a single Electroencephalogram (EEG) recording session. The consensus model will be produced by using the S-Transform of the individual signals and then normalized to unit energy. A bootstrapping process will give a consensus spectrum which will then in turn be filtered by convolution and then the inverse of the S-Transform will give the consensus model. The method will be applied to both a control and experimental EEG to show how the results can be used in clinical settings to analyze experimental outcomes.
Authors: Andrew Young, East Tennessee State University, USA; Jeff Knisley, East Tennessee State University, USA.

Modeling the Effects of a New Class vs. Next Generation Antibiotic on the Spread

of Antimicrobial Resistance in a Hospital Setting
The increase in antibiotic resistance continues to pose a major public health risk leading to a more intense focus on ways to limit and even reduce this threat. One such effort is the push for twenty new classes of antibiotics by the year 2020. Most of the current antibiotics used today are derivations of antibiotics first introduced forty to fifty years ago. In this talk, we develop mathematical models to simulate the difference between implementing a next generation antibiotic versus a new class antibiotic within a hospital setting. Using these models, we simulate the short term and long term effects of using the new antibiotic to combat existing levels of antimicrobial resistance. In addition to analyzing the difference in antibiotic classes, we also analyze the effects of the method of administration of the new antibiotic. Simulations suggest a need in the long term for the development of new classes of antibiotics administered in a very structured, targeted manner.
Author: Michele Joyner, East Tennessee State University, USA.

CS5: Contributed Session V

Pattern Formation induced by delay and diffusion in a Schnakenberg system with gene expression
A delayed reaction-diffusion Schnakenberg system subject to the Neumann boundary conditions is considered. We perform a detailed stability and Hopf bifurcation analysis to the system, and derive conditions for determining the direction of bifurcation and the stability of the bifurcating periodic solution. Delay-diffusion driven instability of the unique constant equilibrium solution and the diffusion-driven instability of the spatially homogeneous periodic solution are investigated. This is a joint work with Eamonn Gaff ney(Oxford), Seirin Lee(RIKEN) and Philip Maini(Oxford).
Author: Fengqi Yi, Harbin Engineering Engineering University, China.

A Comparative Study of Variational Iteration Method and Laplace Homotopy Perturbation Method
In this paper, variational iteration method and Laplace homotopy perturbation method (LHPM) are used to solve the nonlinear ordinary and partial differential equations. Laplace transformation with the homotopy perturbation method is called LHPM. A comparison is made among variational iteration method and Laplace homotopy perturbation method (LHPM). It is shown that, in LHPM, the nonlinear terms of differential equation can be easily handled by the use of He's polynomials and provides better results.
Author: H.K. Mishra, Jaypee University of Engineering and Technology, India.

A potential-based finite element scheme with CGM for eddy current problems
An improved potential-based nodal finite element scheme combining with Composite Grid Method (CGM) is used to solve 3D eddy current problems. In our scheme, introducing a magnetic vector potential and an electric scalar potential is justified as a better way of dealing with possible discontinuities of coefficients. By appending a penalty function to the potential-based formulation, the existence and uniqueness of approximating solutions are ensured. Some computer simulations of the magnetic flux density and eddy current density for two eddy current benchmark models (TEAM Workshop Problem 7 and IEEJ model) are demonstrated to verify the feasibility and efficiency of the proposed algorithms.
Author: Tong Kang, Communication University of China, China.

Communication protocols based on CAAA attributes
We have introduced a system and method of extensible authentication protocols (EAPs) based on Elliptic Curve Cryptography and Symmentric Key Encryption with a permutation technique evolved. The permutation in our EAPs is a process of cubing a random number w.r.to a prime (p = 2 mod 3). These EAPs are compatible with 3G and 4G networks and no certificates exchanged during the communication. Further, they play an important role to fulfill Confidentiality,

Authentication, Authorization and Accounting (CAAA) issues. **Author:** N. Vijayarangan, Tata Consultancy Services, India.

IP4 Plenary Talk: Searching for Diamonds

Given a finite poset P, we consider the largest size $La(n, P)$ of a family of subsets of $[n] := 1, \ldots, n$ that contains no (weak) subposet P. Letting P_k denote the k-element chain (path poset), Sperner's Theorem (1928) gives that the largest size of an anti-chain of subsets of $[n], La(n, P_2) = \binom{n}{\lceil n/2 \rceil}$, and Erdos (1945) showed more generally that $La(n, P_k)$ is the sum of the k middle binomial coefficients in n. In recent years Katona and his collaborators investigated $La(n, P)$ for other posets P. It can be very challenging, even for small posets. Based on results we have, Griggs and Lu conjecture that $\pi(P) := limit_{n\to\infty} La(n, P)/\binom{n}{\lceil n/2 \rceil}$ exists for general posets P, and, moreover, it is an integer obtained in a specific way. For, $k \geq 2$, let D_k denote the k-diamond poset $\{A < B_1, \ldots, B_k < C\}$. Using probabilistic reasoning to bound the average number of times a random full chain meets a P-free family F, called the Lubell function of F, we prove that $\pi(D2) < 2.273$, if it exists. This is a stubborn open problem, since we expect $\pi(D2) = 2$. It is then surprising that, with appropriate partitions of the set of full chains, we can explicitly determine $\pi(D_k)$ for infinitely many values of k, and, moreover, describe the extremal D_k-free families. For these fortunate values of k, and for a growing collection of other posets P, we have that $La(n, P)$ is a sum of middle binomial coefficients in n, while for other values of k and for most P, it seems that $La(n, P)$ is far more complicated.
Author: Jerrold Griggs, Department of Mathematical Sciences, University of South Carolina, USA.

Poster Session

Search for Cyclic Optimal Path in the Reflected Quasipotential Problem

The search for a Cyclic Optimal Path for the Reflected Quasipotential in more than two dimensions is of importance in the literature. We describe our search (joint with M. Day) for such a cyclic optimal path in the three dimensional positive orthant where the Skorokhod problem is well posed. To accomplish this we assume"symmetry" on the faces of the orthant so that the cost along each axis has the same basic structure. This allows us to identify a cyclic path with a fixed point for a function based on the Skorokhod problem for paths which cross a face. Our findings show that a unique cyclic optimal path does not exist for a particular class of examples and may not exist at all.
Author: Kasie Farlow, Virginia Tech, USA.

Applications of Pattern Avoidance in a Cryptosystem

An encryption system should have three criteria:

Security: no useful information should be gained from discovering any part of the system at any given step;

Runs in a "practical" amount of time;

Functions of the system must be easy to evaluate but difficult to invert.

Due to new technology, current systems are outdated and must be revised. We explore these criteria via permutations and patterns.
Author: Katie Milhous, Georgia Southern University, USA.

Adjusting the Wiener Index and modeling chemical compounds

The structure of a chemical compound is often simplied to a molecular graph with vertices representing atoms and edges representing bonds. In this note we consider a classic graph index

called the Wiener index that was proposed based on the observation of its correlation with the physical-chemical properties of a chemical compound with the corresponding chemical structure. We conduct initial trials for modeling the structures better based on the interaction of their electron cloud and will give partial results. This is joint work with Zanetta Geohagen and Hua Wang.
Author: Alex Collins, Georgia Southern University, USA.

Dynamic response of a floating cylinder subjected to coupled wave and wind loading
The objective of the research presented herein is to analyze dynamical interactions in offshore structure under combined wind and wave loads for use in better estimation of power delivery and reliability in hybrid wind-wave generation systems. A model for an inclined floating cylinder at finite depth employing linear wave theory coupled with wind-induced effects is developed. The effects of wind induced forces and oscillations on the structure (i.e. the floating inclined cylinder) are studied by modeling the wind as a mean velocity profile superimposed by turbulent velocity fluctuations. Effects of vortex shedding are considered in the flow around the cylinder. Cross-flow principle is finally used to calculate the wind loads on the cylinder. Assuming small wave steepness and a large radius of cylinder, linear wave diffraction and radiation theory coupled with wind-induced effects is employed to analyze the loading response of the inclined floating cylinder. Numerical results of the dynamic response are presented and discussed while highlighting the increasing relevance of such modeling strategies for hybrid wind-wave power generation systems and their control.
Author: Hang Yu, University of North Carolina at Charlotte, USA.

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